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THE EFFICIENCY OF ENGINEERING PERSONNEL IN THE NAVY.

By Walter M. McFarland.

The grave danger to the efficiency of the Navy which lies in the false place accorded the engineer has, we fear, increased rather than diminished within the last few years. It is insidious because it works wholly out of sight, for the most part, of that influential public opinion which would enforce a change if the conditions were thoroughly and widely understood.

The Bennington disaster is a sudden and shocking revelation of how far things have gone, in the United States Navy, on the road which leads to impotence as a sea power. The accident, probably unparalleled in the merchant marine, can be traced directly to conditions which would never be tolerated in the merchant marine. If such dangers spring from the Navy policy toward the engine room in the ordinary routine of peace, what might be expected in the stress and emergency of war?

We are glad to offer, in the following two articles, the authoritative views of men amply able to speak for the navies of the United States and of Great Britain. The remedy can come only by a process of education, changing gradually the traditional attitude toward the engineer on shipboard. But we believe, with Mr. McFarland, that when the "men at the top" accept and entertain ideals which put engine-room service at least equal with deck service in point of honor, dignity, and recognized achievement, all tendency to discriminate between the two branches will disappear.—THE EDITORS.

THE condition of the engineering personnel presents at this time one of the most difficult problems which confront the authorities of the navies of the world. Although several different schemes of administration are being tried, none gives complete satisfaction. The following article shows that this is the case in Britain. The reports of the Engineer-in-Chief and the proposed schemes of the

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Secretary of the Navy prove it for the United States. In other countries, the engineers themselves have been dissatisfied and discontented for years because they have not been accorded the rank and position to which they are entitled. What is the reason?

A careful study of the situation suggests that the trouble is due to the coming of an inevitable change in one of the most conservative of organizations—the Navy; and to the opposition or inertia of those who have been trained for years under the old order. Steam was at first barely tolerated, and the men who guided its use had no rank at all. It was even accounted a concession in those early days of "the cat" that they were not to be flogged. In the American Civil War, engineering played a great part under the talented Isherwood; but not long after its close, Admiral Porter would have stopped its progress by removing all the fixed propellers and substituting hoisting screws, so that sails would be the usual motive power, with the engines for use only in emergency. He was a sailor, pure and simple. As late as 1885, he went on record as opposing for the new United States Navy the arrangement of sails as an auxiliary to steam, saying that it should be just the other way, with steam as auxiliary to sail power. Of course this was an anachronism, but it was only an extreme manifestation of the feeling shared by a large part of the sailor element. There were, it is pleasant to record, highly progressive officers, like Commodore Foxhall Parker, who advocated mastless ships twenty years before they came.

As the wheels of progress turned, machinery came to play a more and more important part in the economy of the war vessel, affecting not only the motive power, but the guns, the steering gear, torpedoes, etc. Although the sailor officers were largely indifferent to machinery when used for propulsion only, they took hold of it for the matters that were under their own purview until, towards the end of the last decade, a really efficient deck officer had to be a pretty good engineer, and some openly asserted that they were engineers.

This was the condition of affairs in the United States Navy when Mr. Roosevelt became Assistant Secretary in 1897. There had been going on all these years a long and acrimonious strife, mainly between the engineers and the deck officers, owing to the demands of the former for position and rank adequate to their duties and responsibilities. To the protagonist of the "strenuous life," who had just come from the daily combat of the Board of Police Commissioners in New York, the naval strife was a tame affair; but he loves efficiency, and with his keen insight, soon discovered that efficiency was being sacri-

ficed to bickering and jealousy. Suggestions for improvement had been made by many true friends of the Navy, and these led Mr. Roosevelt to take active steps toward a solution of the difficulty. The method proposed eventually took form as the "Personnel Act" of March 3, 1899, under which the Navy is now working. Its essential and basic feature is the amalgamation of the engineers and deck officers, with the avowed purpose of making every executive officer an engineer as well as a seaman.

I was a member of the Board which framed the bill and took an active part, by Mr. Roosevelt's selection, in its presentation to Congress and in the public press. I still believe in the correctness of the principles of the bill, and concur heartily with the repeated statement of my old chief, Admiral Melville—"If the scheme of the Personnel Bill is administered with an honest desire to make it a success, it will produce high efficiency." The obvious inference was that if administered without such a desire, we would have inefficiency. From all that can be learned by diligent inquiry, this is exactly what has happened.

It was pointed out by many persons, including members of the Naval Committee, that the Personnel Bill was weak in not giving detailed instruction about the education in engineering and the performance of engineering duty. I replied that these were really matters of regulation by the Navy Department and did not belong in the bill. I could not then believe that the Department would fail to carry out the plain intent of Congress, and would neglect such a vital element of naval efficiency as engineering. Events have proved that I was too trustful—not to say entirely wrong.

When an almost identical plan was adopted for the British Navy, more care was taken on this point, and it seemed as though the "new model" would here prove its efficiency. It would appear from the following article that this view is also too sanguine. At all events, the kind of modification which it is receiving cannot fail to ruin it. The idea of putting firemen in responsible charge of the watches under steam seems impossible to one who has ever stood a steaming watch on a modern war vessel. Things had not gone to quite so low a plane as this on the Bennington, but the disaster there was due simply and entirely to the utter neglect of proper engineering training and administration. The axiom that like causes produce like effects is not suspended in the case of naval engineering, and if the same neglect is allowed to obtain on other vessels, we must expect similar disasters.

Soon after the Personnel Board had made its report, I published,

with the sanction of the Navy Department, an article explaining the scheme and defending it against the anticipated charge that it opposed specialization (which has frequently been made), and also the intimation that the propelling machinery would be neglected. I said substantially that, in my judgment, the motive machinery *ought* to receive better care because, under the new plan, where every officer was to be an engineer, the captain would have the same professional interest in the motive power as in the guns, and it would be "my engines" and "my mechanics" instead of "yours." Any mishap to the motive machinery would be a reflection on the whole corps of executives and not on a special body of engineers. In theory, this is as true now as when it was written in 1897, but it has not worked out in practice.

The reasons for the failure to carry out the provisions of the Personnel Law seem to be closely akin to those which for so long a time hampered the advance of scientific and technical education. Almost the whole of the staff of instructors in the colleges had been trained in the old classical method. They considered the other courses distinctly inferior to their own carefully embalmed learning. A grudging consent to the pursuit of these courses in the same institution was nevertheless joined with insistence upon a different degree, which they proclaimed to be of a lower order than the standard A.B. Time has gradually removed these intense conservatives and now, in the more progressive universities, the classicists are off in a small corner.

The tone of the naval personnel depends almost entirely on the higher officers, those of command and flag rank. The ideals which they hold up to the younger officers are the ones that are eagerly followed. In the decade following the Civil War, when Admiral Porter was supreme, this ideal was the bold sailor who carried canvas till it blew away. As Commodore Foxhall Parker said, a little later, "Not to talk rope was not to be a seaman, in the opinion of most officers." As a result the midshipmen "talked and thought rope" continually, and exerted every effort to become fine seamen. Can there be any doubt that the same encouragement of engineering, which is now the vital element, would produce equally good results in arousing an enthusiasm to become competent engineers? Unfortunately, the actual conditions are very far from such an ideal. One would expect that, if no officer with actual engineering training is available, the one detailed would at least be a man of considerable experience and chosen from near the top of the list of those on board. In many cases, the exact reverse is true, and the nominal chief engineer is one of the juniors with scarcely any experience of any kind. The unfortunate lad who was in charge

of the Bennington's machinery was next to the lowest commissioned officer.

The following article very truly states that, when choice is given between the normally easy and pleasant duty on deck and the much harder and less agreeable duty in the engine room, very few will fail to select deck duty. The obvious moral to be drawn is that which many of us clearly saw when the scheme was started—namely, that all watch officers must alternate at very short intervals between the deck and the engine room, so as to be thoroughly at home in either place.

It has been demonstrated repeatedly that officers will perform cheerfully the most disagreeable duty, when it is a regular part of their functions, and this simply confirms what has been said before—that the whole solution of the problem rests with the officers of high rank. If they encourage engineering and make engine-room duty as regular and frequent as deck duty, the conditions planned by the Personnel Law will be carried out and we shall have high efficiency.

In spite of such occasional anachronisms as the building of sailing ships for the training of officers who are to serve in mastless steamers, the great fact remains which was so thoroughly grasped and stated by Mr. Roosevelt, namely, that the thoroughly efficient officer on a modern war vessel *must* be an engineer, whether he wants to or not. The efficient care of the motive machinery is just as much a part of his duties as the care of the guns, turrets, or torpedoes. Unless the integrity of this great department is assured, no amount of skill with the guns will prevent disaster in the day of battle. It has already come, on the Bennington, under the usual conditions of every-day routine. What, then, could be expected during the excitement of combat?

A careful study of history should teach us patience. No great forward movement ever went in an absolutely straight line. Because in recent years the British Navy has been highly efficient, and because it is justly proud of Drake, Frobisher, Nelson, Collingwood, and others, we are apt to think it was always efficient. History tells us, however, of "gentlemen captains" who knew nothing of ships, but a great deal of the etiquette of courts; and of officers who were really seamen but were left without pay. Within a hundred years after the defeat of the Spanish Armada, the British Navy had become the despair of its friends and the contempt of its enemies. The period of evolution was very long before the Navy was regularly organized on the efficient basis of combining, in the same man, the resourceful executive and the skilled manipulator of the motive power. The same problem, with the kind of motive power changed, confronts us now. There is no excuse

for long delay in adjusting ourselves to the changed conditions, and the only explanation is the conservatism and inertia of human nature. Progress is vastly more rapid now than it was three-hundred years ago, and our naval men should not move at a slower rate than the great executives of business and industry in making the organization fit the work to be done.

To hold that the scheme of the Personnel Law was perfect in all its details would be claiming a great deal, but a careful study of the history of navies and of present needs makes it seem almost certain that the plan finally adopted must be along its general lines. In ancient times the soldier element was supreme, because the real fighting was done when movement of the vessels had ceased and they became merely the field on which a hand-to-hand conflict was waged. In the modern sea fight everything depends vitally on machinery—the movement and direction of the vessel, the loading and pointing of the guns, the manipulation of the torpedoes. Under these conditions, victory will assuredly rest with that fleet whose officers are professionally competent to control and use the tremendous energy of the machinery for which they are responsible; and they only are thus competent, whatever their actual titles, whose training and experience have made them skilful engineers.

BRITISH ADMIRALTY POLICY AND ITS CONSEQUENCES.

A Naval Contributor.

MANY people were intensely sanguine, when Lord Selborne's famous "Memorandum" startled the world on the morning of Christmas Day, 1902, that at last the burning question of the rank, titles, and executive authority of naval engineer officers had been permanently solved; and that henceforth there would be peace between the two real executive branches of the Navy. When the First Lord of the Admiralty had advanced sufficiently along the road of scientific progress to be able to pen the words which follow, the naval engineer as well as the ordinary civilian might well be excused for

falling into the very pardonable error of believing that the written document conveyed the real meaning of the First Lord's projected new policy. The words referred to appear in the third paragraph of Lord Selborne's "Introduction," and read thus:—

> "The application of steam to ships of war as a source of motive power was the first sign that the old order was beginning to change. At first admitted grudgingly as an occasional auxiliary to the sails, then acknowledged as an equal partner, then winning for itself *supremacy*, today the steam engine has no rival, and sails have forever disappeared from the equipment of fighting ships."

Well might those who for so many years had watched with mistrust and anxiety the heartbreaking nepotism of the sailor element at the Admiralty and throughout the service generally—well might they flatter themselves that the dawn of a brighter era had burst upon the Navy and the naval engineer; that at last the great science which—even under the most strenuous opposition—had succeeded in proving its right to be considered, if not the first, at any rate the second great factor in naval warfare, was to have its rightful place; that now we were to see steam and the engineer taking their proper position in the naval service, and becoming, as it had always been contended by progressive and unprejudiced minds they should become—the colleagues and equals of the sailor element. There was one dominant, irrefutable truth standing out clear as the beam of light from the electric search-lamp, and throwing its penetrating rays over the wide expanse of the Navy and the empire it was created to defend—and that truth was, that a new candidate had arisen to dispute the predominance, the supremacy, of the sailor's art, and to claim rights as his co-equal and coadjutor in all things naval.

The rôle of Nelson's successors had become that of the steersman and navigator, and the man behind the gun. The propulsion and manœuvring of the ship had passed into the hands of the mechanic down below. As time went on, more and more of the functions of the warship devolved on him, until he had become so pre-eminently the arbiter of its fortunes that even his most determined opponents came to realize that either they must take up engineering, or be content to play second fiddle in the naval orchestra. So thoroughly did the sailormen, at the Admiralty and in the ward-room, realize that the command was passing from their hands into those of the "man below," that they were naturally aroused from the slumber of security into which their long and hitherto undisputed reign had plunged them. Recognising the indisputable claims of their successful rivals, they suddenly awakened to the fact that they must either take to engineer-

ing themselves, or be content to see themselves relegated to the second position in the rule and government of the Navy. That things had come to this pass they acknowledged only among themselves, in the privacy of confidential whispers. Towards the world and their rivals, they maintained the aggressive superiority with which years of dominance had apparently invested them.

As the anomaly of their position became daily more evident and conspicuous, a very real attempt was made by the Board—at the instigation of the gunnery officers at first, and afterwards followed up by the torpedo men, as they were made, or created—to usurp some of the functions pertaining to the engineer, with the hope of finally relegating him to his engines and boilers. When it was found that this policy was ineffective, they began to cast about for another, which, while soothing the "struggling lion," should permit them to retain at least a semblance of supreme power. Their desire was to have the command, to be engineers in name, though not in fact, and still to preserve unsullied the exquisite whiteness of their immaculate hands; if by any means they could become engineers without incurrring that last and crowning indignity, the workingman's hand. Some of them even went so far as to throw a sop to Cerberus by actually erecting a toy lathe in their cabins, under the delusion that when they could turn a bit of iron or gun-metal into some definite form they might arrogate to themselves the title of engineer. And their superiors—who chafed uneasily under the consciousness that a power which they could not control was rising to take command of the Navy—encouraged them in the delusion; belittled the naval engineer as far as it lay in their power to do, and sought by every means at their command to stay the coming of the new king. Needless to say, these efforts were vain. Science, with irresistible advance, which no power on earth could arrest, gained upon them day by day, until eventually they found themselves with their backs to the wall, and nothing left for them to do but to surrender at discretion. Sir John Fisher, one of the ablest of the gunnery men, was really the inventor of the New Scheme, though it bears the *imprimatur* of the late First Lord of the Admiralty —Lord Selborne.

The Scheme is decidedly clever! It aims at nothing less than "getting the lion inside the lamb," and it is proposed to accomplish this end, by the usual method of fascination of the victim. The Lords Commissioners of the Admiralty appear to have supposed that the engineers would be taken in by such trifles as "titles" without the attributes which have hitherto accompanied them. They appear to

have thought that the mere fact of calling them officers of the executive branch, whilst withholding from them the exercise of executive authority, would be sufficient to blind the engineers to the deception which was being practiced. One could use some very strong language in dealing with this matter, but it is needless; the shame of the thing will come home to its instigators and concoctors. Did they for one moment believe that such a sentence as is quoted below would satisfy the aspirations of the naval engineer? Legitimate aspirations, be it observed, for one of their own class, an admiral, had said years before, that in his opinion "an engineer officer should have the power to give an order to any man in the ship, without any possibility of that order being disobeyed or even questioned"; and this is what they offered:—

> "The pay of the existing engineer officers will be raised, but no changes will be made in their uniform or in the regulations which define their duties or in the provisions of the Naval Discipline Act."

If any of the executive officers who assisted in the drawing-up of the New Scheme "laid the flattering unction to their souls" that the engineers would be content with such a fraudulent prospectus as that, they must be even greater dupes of their own imaginings, than they considered the men would be to whom they paid so poor a compliment. Executive command, and control of the men in their own department, has been the foremost demand of the naval engineer. Whether he be given executive rank, title, and authority by the provisions of a new Naval Discipline Act or not, he still has to exercise control and to command his men, as best he can, for there is no other by whom it can be done; and this being so, the engineers have endeavoured to show to the Admiralty how much easier such duties could be accomplished, if military command were devolved upon them, with the outward symbols marking executive rank, and the powers which accompany executive rank in the sailor branch. The contention of the executive officers has been that the engineer is not trained to command! This contention is especially emphasized in paragraphs 9, 10, and 11 of the "Introduction" to Lord Selborne's Memorandum, from which the following sentences are selected, the italics being my own:—

> "In dealing with this question (i. e. the question of 'a more general scientific training') the Board have been always conscious of the supreme importance of preserving to the Naval Officer *his unmistakable naval character*" (par. 9).
>
> "This character is developed from the *early training in responsibility*, the *powers of self-reliance thereby engendered*, and the essential unity of the Service." "It is true that no student will ever become a victorious leader unless he is also a practical seaman and *has the power of influencing men*" (par. 10).

> "The strength which its unity gives to the Service can hardly be overestimated, yet in respect of this very matter a strangely anomalous condition of affairs exists. The Executive, the Engineer, and the Marine Officers are all necessary for the efficiency of the Fleet, they all have to serve side-by-side throughout their career; their unity of sentiment is essential to the welfare of the Navy; yet they all enter the Service under different regulations, and they have nothing in common in their early training. The result is . . . that *the Engineering Officer has never had any training in Executive duties*" (par. 11).

Obscure as portions of these sentences are, one unmistakable meaning pervades them all—that the training of the engineer officer does not fit him for command of men! The absurdity of such a contention is obvious. He *has* to command men; and he and his predecessors have commanded men ever since steam was introduced into the Navy. That his command would have been more effectual, of higher value to the Service, if he had been from the first invested with full executive rank, uniform, and authority, it is not now necesssary to insist—we have Lord Selborne's own words to show that it was this one thing which the engineer officer lacked. That he has struggled so long against the stream, and with such marked success, only emphasizes the greater success which would have been attained had he possessed the powers for which he asked.

The attitude of the Admiralty on this subject would seem to indicate that there exists a racial difference between the men who form the executive, and those who fill the ranks of the engineering branch of the Navy. It is the old fetish of the days of feudalism, which has never yet been extirpated from the naval and military services of Great Britain. The substitution of a system of common "Supply," "Entry" and "Training" show that the Admiralty still indulge in the mistaken notion that naval officers of the three executive branches of the Service cannot possibly fill their respective positions, unless they originally come from one source. No theory was ever evolved from more unsubstantial premises. What has been the history of the engineering department of the British Navy since its inception? Has it not been in a marked degree successful, progressive, anticipatory? Has it, as a whole, ever been found wanting in initiative, in resourcefulness, in courage, in resoluteness, in all the attributes which go to make leaders of men?

I venture to assert without fear of contradiction—even from the most influential member of the opposite side—that if the records at the Admiralty were searched, those of the engineering branch would be found well able to hold their own with any other branch, and espe-

cially so with the executive branch. Look at the number of inventions, now in use in the Navy, the greater part of which have come from the engineering branch. Who was it who introduced the water-tube boiler into the Navy, when the superintending engineers of the great mercantile navy stood aloof and would none of them introduce them into their ships—aye, and many of them even now refuse to do so? And yet where would the British Navy be today but for its water-tube boilers? It required an immense amount of courage, and those other attributes enumerated above, to enable the Engineer-in-Chief to go forward against the torrent of adverse criticism which followed his bold administrative action; and many a stronger man might have collapsed under the weight of the bitter professional opposition he had to endure. But is there any question today as to the soundness of his decision? Is it not the fact that in every squadron those ships which the Commander-in-Chief can most certainly rely on at all times and in all circumstances, are those with the water-tube boiler?

Hitherto this paper has dealt only with the New Scheme as propounded in Lord Selborne's notable Memorandum of Christmas Day, 1902. Recently there has been published a "Blue Book" (Cd. 2791) containing "A Statement of Admiralty Policy." On carefully reading through its pages one finds that a change has come over the Scheme. As it emanated from Lord Selborne, it was stated distinctly that after attaining a certain rank in the Navy, the officers entered under its provisions would separate into the three branches of the Service for which they were especially fitted—the executive, the engineering, and the marine. The following is the text of Lord Selborne's note on the subject:—

> "When the young officers, aged 19 to 20, have passed out of the College at Portsmouth as sub-lieutenants, and have gained their classification in the different subjects of the examination, their careers for the first time will begin to diverge, and they will be posted to the executive or to the engineer branch of the Navy or to the Royal marine. As far as possible each officer will be allowed to choose which branch he will join, but this must be subject to the proviso that all branches are satisfactorily filled. No sub-lieutenant will be compelled to join a branch for which he did not enter as a boy when applying for a nomination, but in giving nominations for competition for entrance to the 'Britannia' preference will (other things being equal) be given to those boys whose parents or guardians declare for them that they will be ready to enter either of the three branches of the Service. The Board of Admiralty will thus have in reserve a means of remedying a surplus or deficiency in either of the three branches, and of ensuring that every branch receives a due proportion of the most capable officers."

The Admiralty foresaw, as they most assuredly had a right to anticipate, that that branch of the Service in which are to be obtained the most honor and glory, combined with the power of command, and all the exclusive privileges which follow in the train of the paramount position, was that for which a preponderating inclination would be shown; and in making the stipulation that preference would be given to those boys willing to take either of the three branches, the Admiralty thought they had got over the chief difficulty likely to beset their Scheme. That these pious expectations have not been fulfilled is tolerably well-known in the Navy. It appears to be pretty clearly established as a fact that the voluntary engineering classes have not been attended as fully as the Admiralty desired they should be; and that the voluntary examination papers on engineering subjects have been subjected to "exclusive treatment." In other words, they have been "left severely alone." Of course, if the cadets decided to give engineering a wide berth lest they should be relegated to the "regions below," when they were all anxious to aspire to the quarter-deck and the fore-bridge, the Admiralty design began to lose some of its most hopeful results. There would be no engineers for the Navy! In this dilemma the L. C. A. cast about for a way out of the difficulty. The new First Lord (Lord Cawdor) was prompted (by the Sea-Lords no doubt) to institute a committee

> "to consider whether the time has arrived to formulate regulations for the allocation of the duties of future officers in the various branches of the Service, and to report:—
>
> "(a) Whether any necessity exists for the distinct classification of such officers under existing branches of the Navy, with a view to their remaining specialized for the whole of their future service.
>
> "(b) Whether specialization for a period of their career only is necessary; and if so, to indicate the procedure that should be followed to carry out the necessary duties of the Service afloat.
>
> "(c) How best to provide for filling efficiently the higher scientific appointments of the Admiralty and dockyards."

The New Scheme has been in force only a little more than two and a half years, yet the L. C. A. announce that "The progress of the cadets during their first two years has been most carefully watched and at the close of this period the Board felt that the experience gained warranted them in instituting a detailed enquiry into the probable future development of the new officer." In passing, it may be noted, that the constitution of the committee is not stated. So far as I have been able to ascertain, no engineer officer was on the committee. If this was the case, one naturally asks "Why?" Why was not that branch of the Service represented which is most interested in the

questions submitted for consideration? But what experience could possibly have been gained in so short a time as to render it not only possible, but actually necesssary, to review the provisions of the Scheme of 1902? The indecent haste thus exhibited to tamper with a policy not old enough to have given any reliable indications as to its probable results would seem to confirm the rumours which are afloat in the Service that the New Scheme would not work on existing lines. Parents and guardians, who had promised on behalf of their children or their wards that they would be willing to enter whichever branch of the Naval service they might be selected for, began to dread the possibility of their protégés becoming engineers. They all gave the promise with a sort of mental reservation, that their own particular cadet was not to be selected for any other branch than that for which they designed him—the executive! This is admitted in the report of the committee, though not in such direct terms as it is stated here. The following quotation from page 13, line 18, is the clue to the reason underlying the appointment of the committee in such haste.

> "Uncertainty as to future developments has in some cases exercised a disturbing effect, not only on the cadets but also on their parents and those interested in them."

There we have the whole case in a nutshell. And so we find the committee reporting (page 13, line 20):—

> "Now that sufficient experience of the working of the New System has been obtained, it is desirable that definite regulations for future procedure with regard to the allocation of officers to the various branches of the Service should be formulated and promulgated at the earliest possible moment. This question has received earnest consideration, and, so far as concerns those entered under the New System, it has been decided that all executive, engineering, and marine duties will be performed by executive officers of common entry and training, who will specialize for the different duties without separating into permanent and distinct branches. The consequence of this development of the original proposals is that there will be in future only one class of officer in all departments, and, whether performing engine-room, marine, gunnery, torpedo, or navigating duties, all will be equal, all will be executive officers."

The "bogey" of the engine-room and the stokehold has frightened both the cadets and their friends, and there is little doubt that the Admiralty has been informed by the officials at Osborne that the possibility of being ultimately appointed engineers has caused engineering studies to be evaded, in order that the particular cadet should not be found better acquainted with engineering subjects than his fellows. The wonder is that the Admiralty should ever have supposed that their

scheme would work, in the form in which it was presented in 1902. I do not think any engineer thought that it would. As long as the mode of entry is the same, and the rates of pay the same, and the rate of progression in rank is the same in the executive, the engineering, and the marine branches, naturally enough each cadet will select the executive if any choice be allowed in the matter. The change which the committee has recommended the Admiralty to adopt and which the Admiralty has adopted, will not mend matters a bit. They must face the fact, disagreeable though it be, that inducements must be offered to the cadets to take up engineering, or the engineering department of the Navy will be starved of efficient and capable officers. Is it likely that a young officer is going to take the work "below" if he can by any means get on to the "bridge"? It is absolutely certain that he will not so long as the rank, pay and emoluments are the same. If, therefore, it is desired that the cadets should be willing to enter the engineering line, and remain in it—for it is impossible that the project of eternally moving officers out of a "square hole" into a "round one," and *vice versa,* can ever be made to work—incentives must be placed before them which will induce them to choose the less agreeable vocation.

The Scheme of 1902 convulsed the Service from top to bottom, and the new policy as declared in the "Blue Book" published three years later will not tend to steady its pulse. As far as the engineering department is concerned, this continual change of policy keeps it in a state of effervescence. Neither officers nor men know where they are. The constant changes and suggestions of change keep the whole body in a condition of ferment, and as a consequence this department of the naval service is in a state of unstable equilibrium—a condition which it must be apparent to all who think at all on the matter cannot be conducive to the best interests of the Navy. This instability is increased by rumours which arise from time to time of "confidential letters" to the Commanders-in-Chief of the various stations and squadrons, with reference to the engineering question. At the present time it is currently reported that such a letter is going the rounds of the Flag officers on active service, in which it is suggested, or stated, that no officer of the rank of commander is needed in the engineering department. There would seem to be some foundation for this rumour, when one grasps the real policy of the Blue Book under discussion. For instance, on p. 17, under sub-head (2) in which "The Duties of Engine-room Watchkeeper," are dealt with, it is stated that:—

> "The Admiralty have devoted considerable labour to the subject of the provision of a suitable class of man to help the junior engineer

officers in engine-room watchkeeping. At present this work is done by engine-room artificers, whose chief attainment is that of a skilled specialized mechanic. While in the Navy he is trained and taught engine-room watchkeeping, which results in considerable loss to the Service of mechanical and repairing talent when the ship is under way."

In order to put an end to this loss of their mechanical and repairing talent—which is purely suppositious—the Blue Book goes on to say, on p. 18, that:—

"The engine-room and stokehold watchkeeping can be performed by men specially selected from the stoker ratings of the Fleet, and suitably trained.

"As soon as sufficient stoker ratings are qualified for engine-room and stokehold watchkeeping, engine-room artificers will be released from these duties to do the maintenance and repair work which will, in future, be chiefly what is required of them."

"Leading stokers and eventually mechanicians will be selected from the most capable of the trained stoker ratings. The future mechanician will be the watchkeeping chief petty officer, and will have seniority of command over other chief stoker ratings not so qualified. This substantive rating will carry with it the executive duties of watchkeeper in both engine-room and stokehold."

Here we see that the Admiralty have so little knowledge of the *raison d'etre* of the engineer in the engine-room whilst the ship is under steam, that the Board considers a stoker rating quite good enough to entrust with the complicated machinery of our great warships! Some years ago, a writer dealing with the gradual descent which had been effected by the Admiralty in the matter of watchkeeping in the engine-room, from the engineer officer to the chief stoker, made the following remark, which would seem to be about to be fulfilled: "What is to hinder some future Board of Admiralty taking yet another and another step downwards until we reach that *reductio ad absurdum,* the stoker second class, as the final and ultimate substitute for the engineer officer of 1863?" There is nothing easier than to take a downward step, and successsive Admiralties have exhibited a marvelous facility in this art. The fact of the matter is that the retention of the engineer officer, or even his subordinate warrant officer—the artificer engineer—and the new Admiralty policy, cannot be reconciled; they will not coalesce. And so the stoker has had to be brought in, to try and make the oil and water mingle. As showing the contradictory policy of changing Boards of Admiralty, it may be mentioned that only a few years ago, the then Board issued a very stringent order that in future, a commisssioned officer was always to be in charge of the watch in the engine-room under steam. Owing

to the reduction in the number of engineer officers in each ship, which had then recently occurred, this order compelled the senior engineer also to become a watchkeeper. It had always been a recognised canon in large ships that the senior engineer had quite enough to do in the general supervision of the department, and in carrying out the duties connected with the executive control of the staff, without being further burdened with watchkeeping; but the then Admiralty, moved thereto no doubt by the representations of certain nervous officers, who professed to have no faith in the engine-room artificers, issued the order referrred to. Now we have come to a time when the Admiralty consider that the engine-room artificer is too good for a mere watchkeeping chief petty officer, or warrant officer. At the time when the Admiralty issued the order above referred to, in which it was directed that a commisssioned officer was always to be in charge of the engines under steam, warship engines were much less delicate and complicated machines than they are to-day; and the constant attention and intimate acquaintance with the working of them is more imperative on the engineer officer than it has ever been in the past. Nor is this duty on the part of the engineer likely to become less needful in the future, although with the coming of the turbine some of the executive officers think that they will be able to do without the engineer altogether.

It is unnecessary to extend the limits of this paper. Enough has surely been written to show that the present policy of the Admiralty is calculated to endanger the efficiency of our warships in their most vital part, that of the machinery; and if that goes wrong, the most capable naval commander will be helpless to keep off a lee-shore, or to show a fair pair of heels to the enemy whom he is unable to engage.

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A BACK STREET IN COLON, SHOWING UNSANITARY CONDITION OF NEGRO QUARTERS.

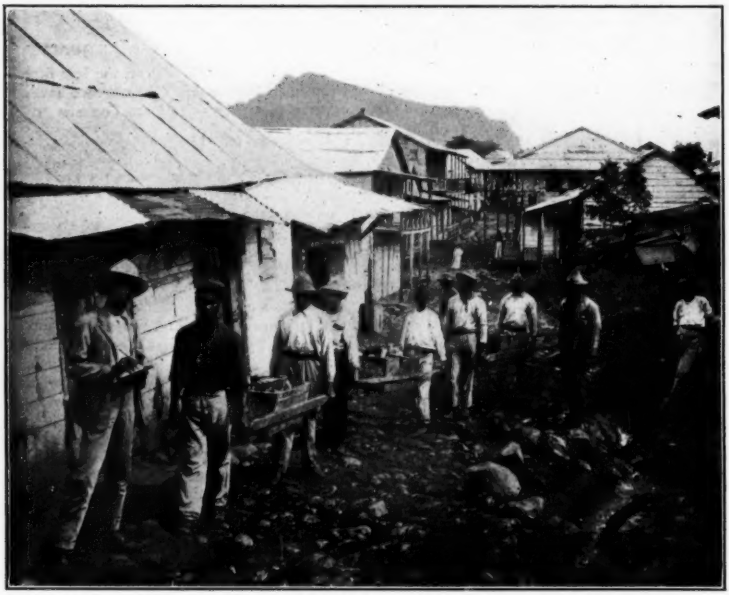
Six large families live in the house on the right, and in the large building on the left fifteen or eighteen families are surrounded by filth as shown in the picture. The negroes have no idea of cleanliness, and it is in these quarters that the work of the Commission is most difficult.

PREPARING THE ISTHMUS FOR CANAL CONSTRUCTION WORK.

By Fullerton L. Waldo.

It may reasonably be hoped that decision on definite plans for the Panama Canal is very near, and that before long construction work in accordance with them will be under way, with the energy and purpose which come from a settled mind and a clearly visualized objective. But it should be fully understood that, so far, no time has been lost. The two years which Mr. Morison presaged as indispensable to the work of preparation, before any large working force should be assembled on the Isthmus, have not yet elapsed. How fully they have been utilized Mr. Waldo's text and illustrations help to show. The subject is perhaps the most important, so far as the field work is concerned, at the present stage. His account has that sane balance between official gloss and sensational attack which attracted so much attention to his description of "An Engineer's Life on the Isthmus" in our issue for December last.—THE EDITORS.

COLONEL W. C. Gorgas, of the medical corps of the United States Army, chief sanitary officer of the Isthmian Canal Commission, has been doing a piece of sanitative work on the Isthmus comparable only, in ancient fable, to the labor of Hercules in cleansing the Augean Stables, or, in modern history, to the work to which Colonel George Waring literally gave his life at Havana.



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THE WORK OF THE SANITARY COMMISSION IN CLEANING CULEBRA.

The upper view shows Main street after the work is finished. The lower one illustrates the garbage gang at work. The men get $2.08 silver per day, and the foremen $75.00 silver per month. Note garbage cans shown in the background.

If one confines one's observation to a very limited field for a very brief space of time, it is perfectly possible to find in some quarters the sanitary conditions which are shown in the first illustration. The picture represents houses of negroes at Colon. Six large families live in the bottle-hung villa to the right, and from fifteen to eighteen families exist in filth and miscegenation in the two-story structure on the left. The picture speaks for itself. But it should be said, by way of a gloss, that the Commission have to make up for four centuries of

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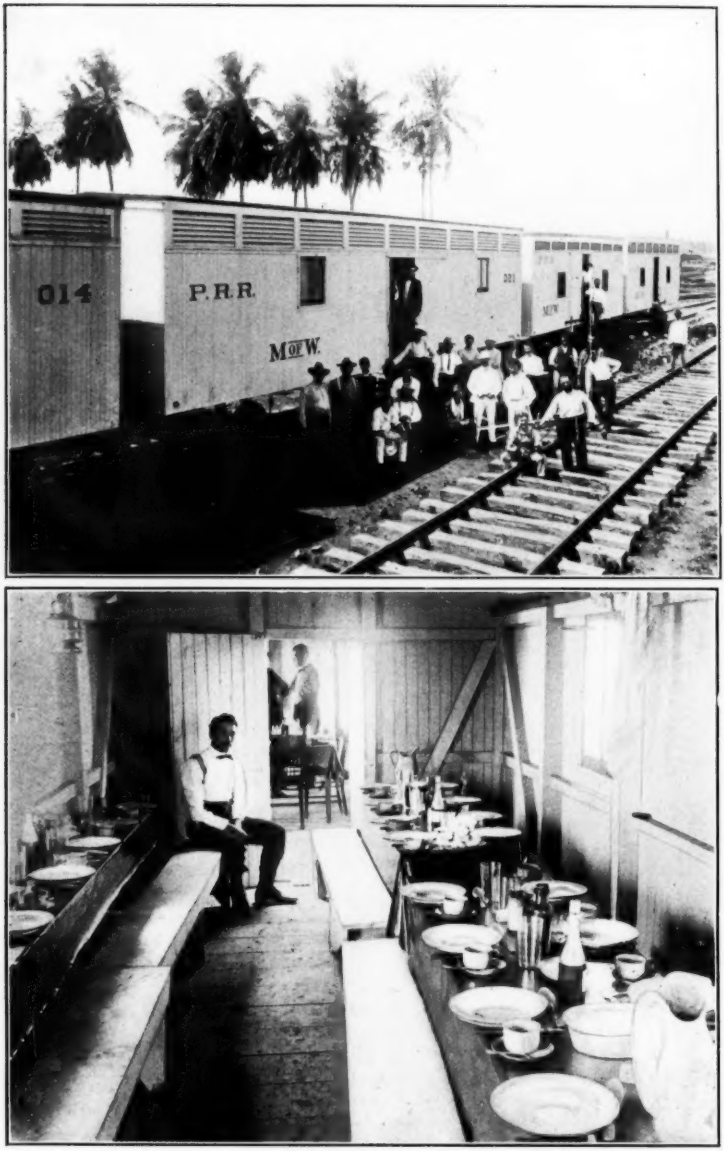
CUTTING WEEDS, MARSH GRASS, AND OTHER RANK GROWTH ON THE EDGE OF COLON.
This entire field is one enormous bog or marsh into which it is impossible for a horse to go, and which affords ideal breeding place for the mosquitoes. However, in spite of all this, the work of the Sanitary Commission has been so thorough in its fight against the mosquito that but few are seen or heard in Colon.

absolute sanitative neglect on the part of the Spaniards and the French. There had never been a bit of plumbing, or a sewer, on the isthmus. So that Gorgas and his men have had to institute a drastic cleansing, in the face of popular indifference, if not opposition, among the very persons who should have been most interested in furthering their efforts.

For instance: in the month of November 2,000 rats—peddlers of disease germs—were caught and killed on the wharves of the city of



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EXTERIOR AND INTERIOR OF CARPENTERS' AND MACHINISTS' DINING CAR, PANAMA RAILROAD.

The P. R. R. furnishes cars, cook, fuel for cooking, and the men provide the food, which costs about 60 cents per day per man. These cars are clean, cool, and comfortable, although somewhat cramped. The meals usually consist of soups, two kinds of meat, two (sometimes three) kinds of vegetables, good bread, jams, and preserved fruits, as well as fresh fruits, coffee and tea, dessert, the usual relishes, etc.

Panama; 231,440 gallons of pure drinking water were distributed in carts in the city, besides what flowed in through the mains of a reservoir opened (to the singing of the Te Deum) by the Americans, July 4, 1905; thirty-four hotels and boarding-houses were regularly inspected; 10,419 crab-holes were probed for lurking microbes; streets were repaired and spread with stone and gravel; pools and swamps were filled up; concrete drains were constructed, and ditches dug to

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A CLAMSHELL DREDGE AT WORK ON THE SANITATION OF COLON.

Showing the amount of water in the soil on which Colon is built. These trenches will be connected with the sea, permitting a fast flow of sea water through the ditches. Roadways will be constructed on each side of the ditch. The dredge was constructed by division engineer's office, I. C. C., out of old French company's waste machines and stock timber. Native residences on sides (right and left). This work is carried on by division engineer's office for the Sanitary Commission.

carry off the polluted water from the supersaturated soil of the villages; dispensaries were established and hospitals built or effectively reorganized; 1,300 doses of quinine were administered daily; 2,200,000 square yards of brush and grass were cut and burned, in the campaign successfully waging against stegomyia and anopheles. Houses were fumigated, to a capacity of a million cubic feet. And all this was but a part of one month's labors of the "unheralded heroes" attached to the

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QUARTERS OF CANAL WORKERS, CRISTOBAL, PANAMA.

In the background are seen men at work improving the already good sewerage system, putting in new concrete gutters, etc.

Department of Health of the Isthmian Canal Commission. The results of it all appear in a succinct cable message, bearing date of February 16, to the Commission at Washington:

> "The report of Col. W. C. Gorgas, chief sanitary officer, shows the health conditions in January to have been excellent. There were 22,000 employees on the rolls. The average daily number of sick was 503, or 22 per 1,000. Seventy-four deaths occurred among the employees, including 26 from pneumonia, principally among negroes. There is no quarantinable disease on the Isthmus. The last case of yellow fever at Colon was reported December 11; the last case at Panama, November 11." (Signed) H. D. REED,
> Secretary to Gov. Magoon.

When the significance of these figures and dates is grasped, it is apparent that there has been a great campaign fought through to victory—a campaign that consisted largely of

> "Getting rid of dirtiness, getting rid of mess,
> Getting rid of doing things rather more-or-less,"—

a campaign against cumulative conditions that would have stifled and paralyzed all possibility of doing any engineering work. No white man could live and labor on the Isthmus if this work had not been done.

An illustration on page 18 shows Main street in Culebra, after it had been cleaned up by the sanitary corps. The contrast with the con-

dition of the negro quarters at Colon is refreshing, and shows what a transformation may be wrought. Many a village of (let us say) Southern Virginia is not half so well-kempt and orderly. The quarters of the married contingent of the canal workers at Cristobal, shown opposite, afford a more engaging picture of the domestic comfort attainable, on a simple and unostentatious scale of living, by the white employees of the Commission. The men seen at work in the il-

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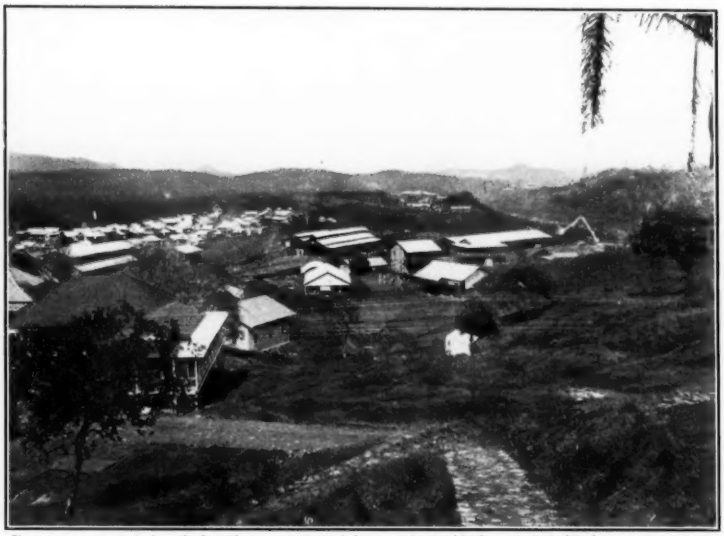
WASH DAY ON THE ISTHMUS.

Native negro women washing clothes in tributary of the Rio Chagres. These women do not believe in any of the favorite washing compounds, for their process consists of a severe rubbing in the hands and beating the work upon the rocks. These women get $3.00 silver per dozen pieces. A handkerchief counts the same as a white duck coat, and six pair of socks count as a dozen pieces.



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VIEW AT EMPIRE, SHOWING CLEAN AND COMFORTABLE HOUSES OF EMPLOYEES OF THE CANAL ZONE.

lustration are improving the sewerage system—which is already good —and putting in new concrete gutters.

The washerwomen of the Canal zone use the waters of the Chagres and its tributaries, wading far out into the stream and beating the life out of the clothing on the rocks. [See preceding page.] They do not use any of the washing compounds which, according to the advertisements, lighten the housekeeper's burden and make of wash-day a kind of festival. As can be seen from the illustration, the cleansing process consists of a vigorous rubbing between the calloused hands of the dusky laundresses. The price paid for the mangling is $3.00 silver per dozen pieces, a handkerchief counting the same as a fancy waistcoat, and a pair of socks counting for two pieces. It is easy to see why salaries on the Isthmus are double those paid in "God's country."

On the whole, the employees of the Commission are comfortably housed, in cool open-work shelters with wide verandas, adapted to tropical conditions. The older buildings in the town of Panama and the villages must go. The Spaniards were blind to the fact that the Roman basilica style of architecture is wholly unsuited to Central America. The Canal Commission had its offices till recently in one of these old stucco structures, damp and badly ventilated, with thick

walls, harboring numberless yellow-fever mosquitoes in its neglected corners. They have just changed to new buildings at Culebra and Emperador. A hotel has been built at Corozal, between which point and the city American employees may use the railway at commutation rates, and at Ancon is another of 128 rooms. There are admirable hospitals at Ancon, at Panama, and at Taboga, an island ten miles out in the Bay of Panama, where pure water and recreative bathing may be had, with abundance of good fruit. The combined capacity of these hospitals is 1,000 beds. Mr. Isham Randolph, the distinguished Chicago engineer, says:

> "The hospitals are a source of just pride to our people. If sickness could ever be regarded as a boon, it may be so thought of in Ancon and Colon."

The hospital at Colon is built on piers extending out over the Atlantic, so that its patients get the tonic effect of the breezes from the sea.

The Commission took over from the French Company some 2,100 buildings, all in disrepair. They have repaired 649 of these, built 58 new ones, and started 67 more, in addition to the hotels above mentioned; 2,400 men are employed in the work of construction, and more builders and carpenters are being sent to the Isthmus on every steamer. Among the recent purchases of the Commission appear the items: 30,000,000 feet of lumber, 3,500,000 building brick, 500,000 square feet of roofing tile, and 36,000 barrels of cement. These figures partly account for the recent congestion of freight at the canal termini,—a serious obstacle to the furtherance of the engineering work.

OUTFITTING FOR THE PROSPECTING TRAIL IN NORTHERN MEXICO.

By Laurence M. Terry.

Mr. Terry's opening sentences indicate so clearly the interest which his theme carries for the engineer in the field that it is unnecessary to do more than add that he is offering the results of long and thoroughly tested experience. Such advice is most valuable, for it is rarely obtainable from a wholly disinterested source, and mistakes too often are discovered when remedy is too late. While Mr. Terry deals specifically with a certain region, many of the points will be of value anywhere.—THE EDITORS.

DURING a ten-years' residence in Mexico, my attention has many times been called (and with no little incidental amusement) to the incongruity of the outfits prepared and brought into that country by those whose business, or pleasure, called them into the Sierras. So frequently has this been the case that a few suggestions from one to whom horse or mule-back transportation is a very old story, may not be amiss.

The average individual contemplating a considerable investment in mines, timber-lands, or other large enterprise, is naturally anxious to visit the scene of the projected operations personally, and for this class of travelers the following few pointers are given, in the hope that they may conduce to the comfort of both man and beast.

The climate of the State of Chihuahua, for example (a State which is largely visited in behalf of the above-mentioned enterprises) is much less equable than the plateau region to the south, and the choice of proper clothing and outfit becomes of prime importance. This choice is governed by the time of year selected for the proposed trip. In the warmer season, which may be taken to begin in April and to extend to about the first of October, it is the habit of the writer to provide himself with the following:—

Three suits of light underclothing, two suits of light-weight pajamas, six pairs of light woolen socks, two light-weight woolen shirts (being careful to get the best grade, for even these shrink all to much), a cravat or two and a dozen handkerchiefs, two pairs of hob-nailed shoes 12 inches high, laced with belt leather lacings through eyelets—not hooks—such as are made by Hanan or Putnam; two pairs of riding breeches, one of khaki and the other of whipcord, made very loose from the knee to about 4 inches below the waistband (which should

THE AUTHOR, IN SINGLE RIG SADDLE.

Showing pommel slicker in roll in front of saddle; *tapaderos* on stirrups; rifle and scabbard. Pack mule equipped with *aparejo* is being loaded in the background.

be just above the hip bones) and fitting snugly from there to the waist, also buttoning snugly from the knee to well below the calf. Two coats and waistcoats with plenty of buttoned pockets, to match the breeches, will pretty well cover the personal outfit, with the exception of toilet articles (of which later), hat, and gloves.

A wide, soft-brimmed Stetson hat, and gray buckskin cavalry gauntlets, or officers' style (Gloversville, N. Y.) gray buckskin gauntlet gloves give the best possible satisfaction, and pipes and plentiful supply of tobacco should not be forgotten by smokers, since the native pipe-tobacco is poor. Finer cigars and cigarettes than the Mexican brands, however, are difficult to obtain.

I have been criticised for advocating the use of hob-nailed boots in the saddle; but if one uses *tapaderos* on the stirrups, the danger of being hung up and dragged, in case of a fall, is reduced to a negligible quantity; and as all experienced trail riders make a practice of walking down all steep hills, the use of hob-nailed shoes, once adopted, will never be discontinued. The nails used should be small, round-headed Hungarian nails, and they should be put into the well wetted sole, heel, and also in the hollow in front of the heel, but should not be too thickly studded. Then treat both pairs of boots with viscol, to make them waterproof; and by all means carry a small can of it with you, for renewals.

In addition to the above personal outfit, a pommel slicker is an

absolute necessity; and a laced-neck sweater is very apt to be needed on chilly evenings.

The toilet articles should be cut down to two bath towels; tooth-brush and tooth powder; soap (I prefer "Ivory," which can also be used for shaving) in a metal soap-box; two razors, strop and brush, comb and hair-brush, and toilet-paper.

For a winter outfit, the addition of a reversible coat (of brown leather on one side and corduroy on the other); a change in the weight of underwear (if this is the custom of the individual), the substitution of heavy overshirts, pajamas, and woolen socks, with the addition of two pairs of heavy Shaker woolen socks for sleeping purposes, will be in order.

This character of outfit avoids the use of leggins, which at least to my way of thinking is a distinct advantage.

Among the articles which are not absolutely necessary, but which I always carry, are low slippers which have had an additional thin sole sewed on. It will be found that in dressing and undressing, as well as for any moving about at night, these prove to be an unmixed blessing.

Having attended to the clothing and toilet articles, the next thing confronting the "tenderfoot" is a choice of armament. Here there are nearly as many ideas as there are individuals. However, it is an undoubted fact that all of the expert pistol-shots (and by this I do not mean target-shots) of the West use the Colt .45 single-action, Bisley model pistol, and this gun, with the new smokeless ammunition adapted to it, is very hard to improve upon. The pistol belt should be made amply long, so that the gun may swing well down on the hip, and should be arranged to hold pistol cartridges for three-quarters of its length, and rifle cartridges for the remainder.

The holster should be a stiff, two-strap one, for nothing is more trying than a soft flap holster which lets the pistol pound you black and blue with the motion of the horse, and from which it is impossible to pull the gun quickly, in case of need. A five-inch Marlow knife and heavy stiff scabbard on the belt is a very useful tool to carry, but the thin glove scabbard which comes with it should be thrown away, and one similar to that shown in the accompanying photograph should be used instead.

A choice of rifles is a matter of individual preference, but a half magazine, round 26-inch barrel, .33 Winchester cannot be improved upon. There will be no need for anything but soft-nosed bullet cartridges, so provide these only. With the rifle will be needed a saddle

BELT, WITH PISTOL AND HOLSTER, KNIFE AND SCABBARD.

scabbbard, and the arm should be carrried with the sights up, thus avoiding deranging or breaking them. Probably a hundred pistol cartridges and forty rifle cartridges will be an ample supply, though if one intends to amuse himself by shooting, more than this quantity will be in order.

The choice of saddles, bridles, etc., comes next on the list; and with most people, it seems to be the usual custom to trust to luck, and count on getting a saddle at the trail starting-point. For a man whose combined Pullman and automobile cushions during a period of weeks will be a saddle on the hurricane deck of a mule, this seems to be a most short-sighted policy; for the Mexican saddle is at best an uncomfortable affair, and for the first few days, the finest of saddles will convince its user that it is no down pillow. By all means bring your own "proved and true" saddle into the country with you. You will have to pay a duty of two dollars Mexican money for each kilo of its weight, or about 45 cents United States currency per pound, but the money will be found to be well expended. What particular make of saddle you use is a matter largely of individual preference, with one reservation—never attempt to ride an English saddle in the mountains! The choice of almost all trail riders seems to be a double-cinch cow-saddle weighing from thirty-five to forty-five pounds, but this has a pommel which, being originally designed to serve as an aid in roping cattle, is of no particular use or benefit on the trail. In fact, I should find it a good deal of a nuisance, since I carry a slicker in a long roll strapped on the front of the saddle.

In getting a saddle, care should be taken to have it amply wide at the withers, for many of the Mexican mountain horses are both high and wide at this point, and if the saddle bears on the bone, a saddle

gall will surely result. Let the tree be large enough to be perfectly comfortable, and have the cinch rig double. A usual fault in eastern-made saddles is that the cinches (or girths) being designed for American horses, are too long for the smaller Mexican stock, so have the cinches proper about 26 inches long, which will be found to work well in practice. Provide, also, a pair of light but strong spurs, with chain —not leather—to pass under the instep.

Get a single big bridle with a short-ported bit, so that your animal can drink without first having his bridle removed. There is on the market a combination halter-bridle in which the bit snaps onto the bridle with snap hooks, making a very useful combination.

The saddle blanket may be a folded single blanket, or preferably a black woven-hair, leather-bound, shaped saddle blanket. This latter is on the Eastern market. Do not get a felt saddle blanket, as such an article rarely, if ever, proves to give good satisfaction.

It is a good plan to provide a canvas bag, with lock, for the saddle outfit, instead of packing it in a trunk. This need not be taken on the trail, but will serve to prevent injury to the saddle and will keep the outfit together in transit.

Get a pair of leather and chain hobbles, and put them in the saddle bag. When you see your pack mules driven into camp in the gray of the morning, chafed raw from the rope hobbles used by your native servants, you will be glad of your foresight in getting the improved articles; if you are not, your riding animal will be.

When it comes to the selection of a bed and bedding, it is easy to err on the side of too little bedding! In the first place, provide a folding canvas cot. This folds up so as to pack readily, and should not be omitted. For the summer trip, take four fairly heavy double blankets and a pneumatic pillow. This may seem excessive, yet I have slept cold with the same equipment as late as the end of May. Take no sheets. These latter are a nuisance, and it is remarkable how soon one forgets to want them in camp. For winter travel, take at least six blankets.

In order to carry your bedding compactly, provide a strip of 18-ounce canvas, 4 feet wide by 8 feet long, and enough ⅜-inch rope to tie the roll comfortably. Lay the canvas on the ground, fold the blankets lengthwise on it, then place the slippers, toilet articles, sleeping garments, and, in fact, everything you will need in the evening and morning, on it, and roll into a tight roll, so adjusting the canvas that there will be an excess length of canvas on the final roll, thus protecting the bedding. Now throw a loop of the rope (it should have

an eye-splice in one end) around the roll, and pull tight. Set the roll on end and fold the canvas in *a la* wrapping-paper; pass the free end of the rope over this end, take a turn in the loop first thrown; throw a half hitch around the roll near the other end; turn the roll end for end, tuck in the remaining end and pass the rope over it; take a turn in the nearest crossing rope and tie to the up-going strand from the first loop thrown—and your bed can go through anything (except rivers) without trouble or damage. For the carrying of your remaining plunder, use a "war" or duffle bag, preferably cylindrical in shape, and locking with a padlock.

ROLL OF BEDDING, SHOWING METHOD OF TYING.

The size of tent to be used will depend largely upon the size of your party; but let it be of thin patent waterproof material, an "A" tent in shape, and arranged to be slung from a rope stretched between two trees; and let it be as small as possible. There will be no necessity to provide a rope for stretching the tent, since the rawhide pack ropes used by the *arrieros* (muleteers) are better than anything else for the purpose.

The usual form of packing appliance in this country is the *aparejo*, which invariably galls the pack mules on the back, and at the root of the tail. Aside from the cruelty to the animals, the prevalence of blow flies (causing screw worms in the raw places) at times causes the death of the afflicted beast, though this applies only to the summer

PACK MULE EQUIPPED WITH APAREJO.

season. The only advantage of the *aparejo* lies in the fact that it is better than a pack saddle for heavy or unwieldy loads, such as barrels or very large boxes; also, in renting pack-mules for a journey, they are always furnished with the native *aparejos.* For such trips as are contemplated in this article, the American army pack-saddle, with breast-rig, breeching, and heavy saddle blanket, is a better and far more humane arrrangement. It should be provided with *alforjas,* or large pack-saddle pockets. This pack-saddle must be bought in the United States (as must also everything heretofore advised) and brought into Mexico with the travelers.

In figuring number of pack animals which will be needed it is well to take not over 150 pounds of load, exclusive of the pack-saddle or *aparejo*—or even less, per animal. Then the pack can be kept up with the riding animals, which is a marked advantage.

The food and cooking outfit usually presents difficulties to the tyro, and his common custom seems to be to have recourse largely to canned edibles. Now, tinned food, while good in its way, is heavy and bulky to pack, and moreover does not seem to be as well suited to the somewhat rugged needs of the *voyageur* as a simpler diet. I recall vividly a trip taken a few years ago where the food part of the outfit was left to a young and enthusiastic member of the party. At the first stop-

ping place it developed that "food" to him meant sardines, corned beef, lunch tongue, *paté de foie gras,* etc., and while his assortment of tinned supplies was both large and varied, still, before a week of hard travel was over with, the entire party of us were more or less under the weather. At the end of this time we providentially reached a rather large mountain town and here we left the tinned dainties, providing ourselves instead with bread, *tortillas* (native corn, or rather ground hominy cakes) *frijoles* (the native bean) fresh and dried beef, etc. Result: in two days the whole party was well and cheerful again.

So confine your selection principally to simple and healthful foods. The list below will serve more or less as a guide, though it is impossible to give any ideas as to quantities, for this depends entirely upon the number of people in the party, the length of the trip, and whether it is the intention to pass through *pueblos* or towns wherein further supplies can be secured.

The traveler will need: Flour, candles, salt, sugar, pepper, lard, bacon, ham, coffee (already roasted and ground), tea, syrup or maple sugar—or *panocha* (native brown sugar) for making syrup for cakes —baking powder, canned butter, Mexican beans (*frijol bayo*), evaporated cream (unsweetened), soap, dried applies, potatoes, onions, rice, oatmeal (or any other cereal generally liked by all the members of the party), as much fresh beef as can be carried and will keep, dried beef (American) for party, and native (or *carne seca*) for the servants; some dried peppers (*chile colorado*) for servants, vinegar;

PACK MULE EQUIPPED WITH AMERICAN PACK SADDLE.

while for lunches, such canned food as may be deemed best may be provided. Matches, in some water-tight receptacle, must not be neglected.

ENGINEER AND OUTFIT, SHOWING FLAT METHOD OF FOLDING AND CARRYING BEDDING. This method is frequently used when it is not necessary to carry food or cooking utensils —as, for instance, on short trips between established camps.

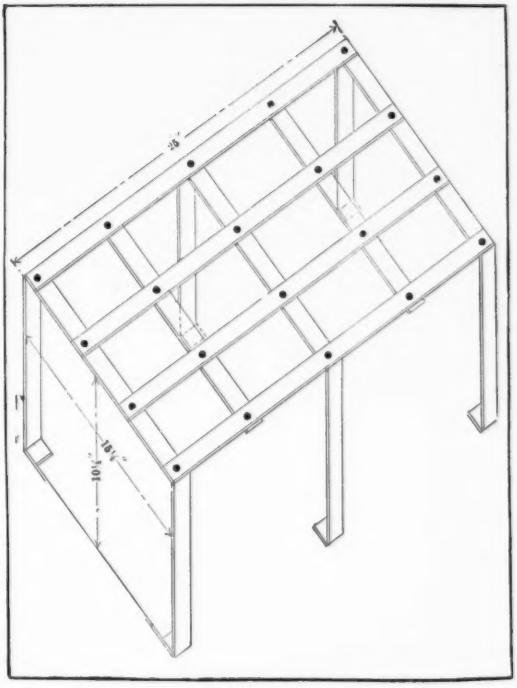
If pack-saddles are selected for the trip, most of the provisions will be carried in the *alforjas;* but if *aparejos* are used, then strong boxes are about the most desirable articles in which to pack the food supplies. They should be rather long, not too wide, and should not be deep. About 30 inches long by 15 inches broad by 10 inches deep outside measurement is a good size, and easy to pack. They should have hinged covers and be provided with a hasp and padlock each.

The cooking and table outfit should be cut down to about the following for each person: one each, knife, fork, teaspoon, dessert spoon, enamel-ware cup, saucer, and soup plate—which latter serves equally well for soup, fish, roast or breakfast cereal! Then, for the mess, several extra soup plates for holding cooked articles, as well as a few tablespoons, and enamel-ware wash basin. Axe, hatchet, a butcher knife, a large wire fork; two or more frying pans; a Dutch-oven for baking bread; a large galvanized-iron water pail; a large stew pot and at least two small stew pails; a large shallow tin pan for mixing bread

and biscuits, as well as a pancake turner. And last, but very important, a cross-barred iron frame, with legs, to set over the camp fire to support the cooking vessels will be needed, as also a coffee pot and tea pot.

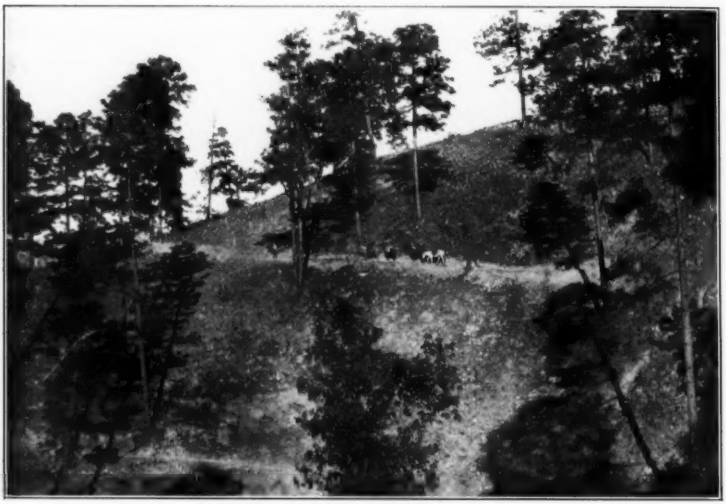
The entire kitchen outfit should be packed in a strong box such as already described, but which is provided with a short stick which will fit into notches cut into the cover and back in such a manner that the covers may be opened out and held in a horizontal position by the stick, thus forming a small table. Two 4-foot squares of 12-ounce canvas will serve as table-cloths, being spread upon the ground.

The food can all be bought at the trail starting point, as a usual thing; but it is perhaps safer to secure all food and cooking supplies at the United States border city,—El Paso, if coming in via the Mexican Central Railway, or preferably San Antonio, if entering via Laredo.



GRILL FRAME MADE TO FIT OVER GRUB BOX.

The grill frame can easily be made by any blacksmith, and if made to the sizes given, will slip over the cook-outfit box, thus taking no extra room in the pack. One should always carry a few simple remedies, such as vaseline, quinine, brown mixture tablets, good liver pills, and castor oil, as well as whiskey. Prompt attention to such afflictions as colds, coughs, and chills will often prevent disaster, for in the high, cold altitude of the Mexican Sierras, colds develope into pneumonia



A PROSPECTING OUTFIT ON THE TRAIL.

with terrible rapidity, and pneumonia is as much to be dreaded as yellow fever. Also provide a mixture of half carbolic acid in crystals and half gum camphor. This last, when mixed, forms an oily liquid which is a certain remedy for screw worms, galls, and cuts on men or animals. Some tallow with which to grease the *aparejos* is also a useful thing which should not be forgotten.

In the warm valleys and gorges, and at times in the cooler heights (during the summer months) a small but persistent gnat, called locally *"jején"* is very painful and annoying. Its bite leaves a pronounced swelling, and when this subsides, a small black spot remains for days. Oil of cloves keeps these gnats off effectually and also discourges fleas, which are at times very insistent; while the carbolic-acid-camphor mixture relieves the intolerable itching caused by the gnat bite.

In setting out on the trail, it is wise to agree upon the various duties to be performed by the different members of the party, and then decide upon some one member to direct the entire outfit. If one man's duty is to cook; another's, to erect the tent and arrange the bedding; and a third's to see that the animals, saddles, etc., are properly cared for, later washing the dishes, there will be no confusion when going into or breaking camp, and arguments will be thereby avoided.

It is advisable to take at least two foot-*mozos* (native servants), though for a large party with a considerable pack train, more will be

needed; and it is to be remembered that if the native servant is given an inch he will expect—and promptly take—the proverbial ell. His food consists of coffee, bread (or *tortillas*), sugar, fresh or dried beef, peppers and beans. If you give him milk or butter, you will later have trouble with him; and there is a saying that the *mozo* who wears shoes and who speaks a few words of English is good for nothing. Experience proves this to be a very sound saying; so pick out sandaled *mozos* for your trail servants, and be happy.

From late June till early October, and frequently later, heavy rains are to be expected; and as the lightning is bad, care should be taken to pitch camp in a spot which will be free from this danger, as well as from falling dead trees. In the winter months, rain, hail, and occasionally as much as three feet of snow may be encountered. In deciding on a camping place, the first desideratum is good water, then grass for the animals, and lastly wood; and after pitching the tent, it should be ditched on the up-hill side.

As a final word, I would suggest that a small covered aluminum canteen of water be carried on the saddle, and that one make it a rule to keep his pistol on his person by day, and under his pillow at night. During ten years I have never been called upon to use a firearm—possibly for this very reason—for a show of force is probably one of the best means of preserving peace.

AT THE JOURNEY'S END.

ATHLETIC FIELD, FOR NOON-HOUR AND VACATION SPORTS.
Works of the N. O. Nelson Mfg. Co., Le Claire, Ill.

THE SQUARE DEAL IN WORKS MANAGEMENT.

By O. M. Becker.

IV. AUXILIARY METHODS OF SUCCESSFUL LABOR EMPLOYERS.

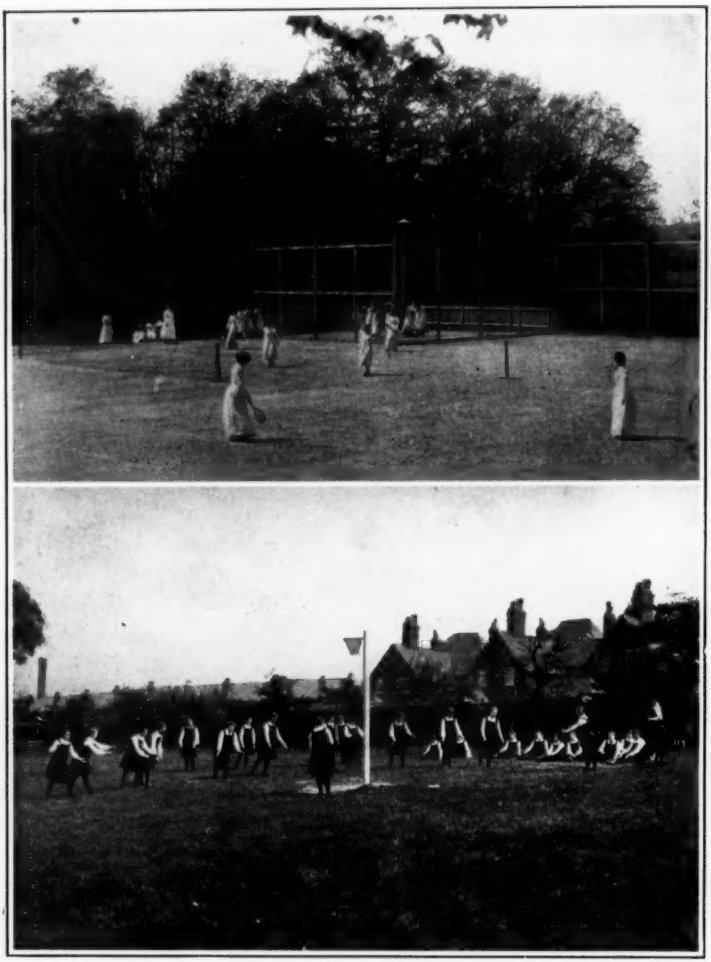
Mr. Becker's series began in the issue of this Magazine for January last; the first portion dealt with "the common-sense of the management of men"; the second took up adaptations of the shop—in matters of design, arrangement, or construction—suggested by modern ideas of the just relations between employer and employee; the third treated of institutions affecting more closely yet the physical well-being of the worker, as to nourishment, hygiene, and other matters formerly regarded as quite outside the purview of the employer. The installment following, which closes the present phase of the discussion, shows the progress made in many factories in the recognition of the social needs of their workpeople, and the sound practical economy which results from well advised effort along these lines.—THE EDITORS.

EVERYWHERE in the physical world the phenomenon of fatigue under tension is acknowledged, even in the case of mental sections. Given intervals of rest—perhaps extremely brief—and no harmful strain results; but without the occasional relief for molecular or cellular readjustment, the steel rod, the animal muscle, or the human brain may collapse. It is generally recognized, by men whose work demands close thinking or even close attention, that there is a period, varying with the individual but fairly definite in the single case, throughout which concentration of thought or perception may be maintained; but that when the limit is reached, there must be a relaxation—perhaps hardly more than momentary—or the productive (or receptive) faculties drop in efficiency at a very rapid rate.

The whole trend of modern factory operations is toward increase of the nervous tension under which the employee carries on his work. The effort to increase production finds expression in high-speed machinery, specialization of the operations performed by any one operator, wage systems stimulating him to the closest attentiveness upon his job. It would seem only reasonable, in the interest of the maximum of effectiveness of each producing unit, that attention should be given not only to the highest output while working, but to the highest recuperative effect in all the intervals of rest.

AFTER-DINNER SCENE IN A FACTORY DINING ROOM FOR FOREWOMEN.
Cadbury Brothers, Bourneville, England. Their female employees are supervised by members of their own sex.

The noon intermission is in many work places so short, often but thirty minutes, that the question of a profitable disposal of surplus time does not arise. Half an hour barely suffices for getting to and from the lunch room and bolting a little lunch, leaving scarcely time enough for cleaning up before eating, even when the facilities for doing so are at hand. If, as is usually the case, there are no lunch-room conveniences, and the men are obliged to eat in the shops or from the street curbs, the time left is yet too short to be of any particular value for recreation. If the longer noon period prevails, as it should in all cases, a systematic effort can be, ought to be, and sometimes is made



OUTDOOR EXERCISE FOR WORKING GIRLS IN A LARGE FACTORY.
Tennis and "net ball" at the works of Cadbury Brothers, Bourneville.

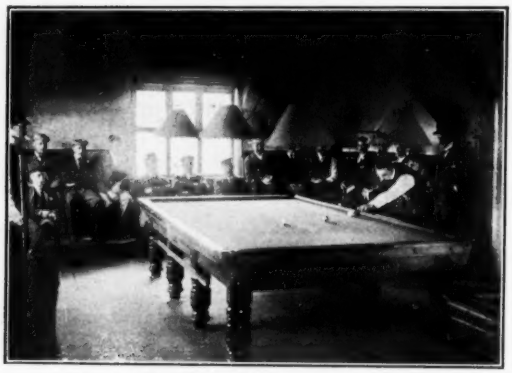
to relax the tension of the workers. During good weather the men and boys usually manage to get some sort of relaxation out of doors. Usually no attention is paid to this part of the workmen's time by the employer. A few encourage the organization of base-ball and other athletic teams, and even help furnish the necessary supplies. Such

recreation is necessarily limited to the few in the "teams," and has small value except as a promoter of loyalty and enthusiasm, because games must be played during holiday times mostly.

LIGHTENING THE DAY'S WORK.
Mechanical piano as a recreation feature. The Sherwin-Williams Co., Cleveland, Ohio.

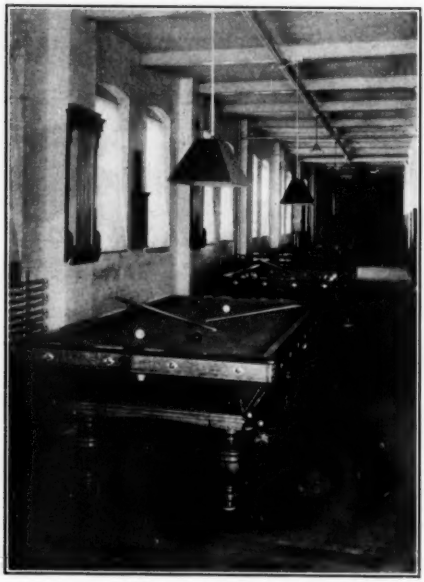
The lunch and rest rooms, when provided, furnish a fine opportunity for an extension of the in-door activities. With little additional expense, or none at all, such rooms can be used after lunch for smoking or recreation rooms. A few extra tables, supplied with papers and magazines, and possibly some games that do not require elaborate appliances, make a good beginning. The rest room for girls ought always to be thus supplied. No elaborate room is requisite to so simple an arrangement. It can be done with the crudest sort of place, if necessary. Naturally, however, a comfortable room fitted with suitable furniture and containing a case of books, in addition to the periodicals already mentioned, makes a more desirable place. The presence of a phonograph and set of records adds to the enjoyment. Some employers have put self-playing pianos into such rooms. In places where this is the case, there is usually dancing, if the floor permits. This is undoubtedly the most popular form of amusement (the excess to which it is often carried scarcely permits

A WORKS RECREATION CLUB.
Sherwin-Williams Co., Cleveland, Ohio.



RECREATION ROOM FOR MEN.
Works of Lever Bros., Port Sunlight, England.

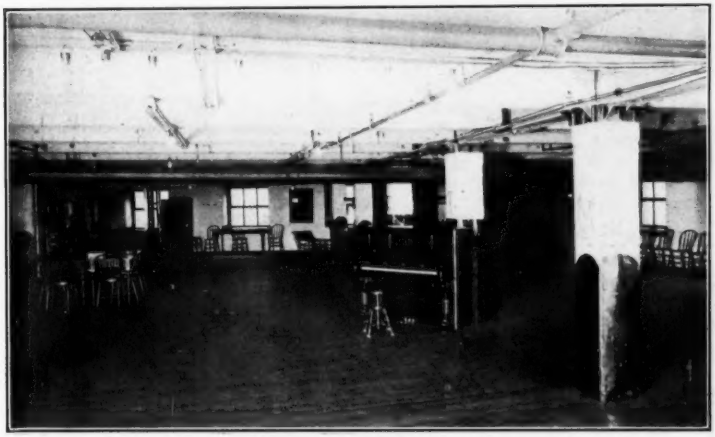
it to be placed in the category of recreations) among women workers; and when opportunity for it is offered, it is greatly appreciated. In a certain large factory about six-hundred girls make use of the lunch room during the early part of the noon hour, and having disposed of their lunches most of them are almost immediately dancing in the adjoining room. On the one day of the week when the men are admitted to the dancing floor it would be difficult to say which sex enjoyed the privilege most. Opening into both these rooms is another, cozily furnished with benches, couches, and rockers, to which those girls may go who are not in a dancing mood. Here also are periodicals and other things to give profitable occupation or relaxation.



RECREATION ROOM FOR MEN IN A MODERN SHOP.
The Weston Electrical Instrument Co.

Such resting rooms are now come to be established institutions in most large industrial and commercial plants. One would say that their absence nowadays is indicative of extreme indifference to the comfort of women employees, to say nothing of the

decencies. It may be nothing more than a suitable corner screened off from an office or shop, containing a few chairs and cots where girls may rest if weary, or lie down if ill. Usually it is a separate room, cozily fitted up, neatly decorated, and furnished with some ordinary conveniences. The decorations and pictures give it an air more homelike than that to which most of the girls probably are accustomed, and thus become effective agencies in the development of a better standard for the home life.



DANCING FLOOR ADJOINING GIRLS' LUNCH AND REST ROOMS.
McCormick Twine Mill, Chicago. Much used for recreation during the latter part of the noon hour.

The rest rooms for men are not as yet looked upon with favor, though there are notable instances where such have been used. Perhaps the name "rest room" does not well describe most of these. They are most frequently stopping places for employees of railroads and street car lines, rooms where employees may spend their time between trips, or when off duty. Naturally such places are supplied with books and other reading matter, and it is desirable that there be also other forms of amusement. But a room where a weary workman might rest, or recover himself if faint, is something for which the industrial world is scarcely prepared, though they are not so uncommon as may be supposed, particularly in Europe.

The weaknesses and ills of women appeal to the sympathies of managers, and the need for a resting place for them is pretty generally recognized. An hour's rest in case of sudden faintness or illness is often all that is required to permit of a return to work. The lack of

FACTORY REST ROOMS FOR WOMEN.

The upper one, very simply designed and arranged, is in the factories of the Sherwin-Williams Co., Cleveland, Ohio. The lower is in the works of the National Cash Register Co. Every department has its rest room.

opportunity to do so necessitates the loss of the remaining part of the day to both employer and employee, or an aggravation of the illness in the endeavor to continue at work.

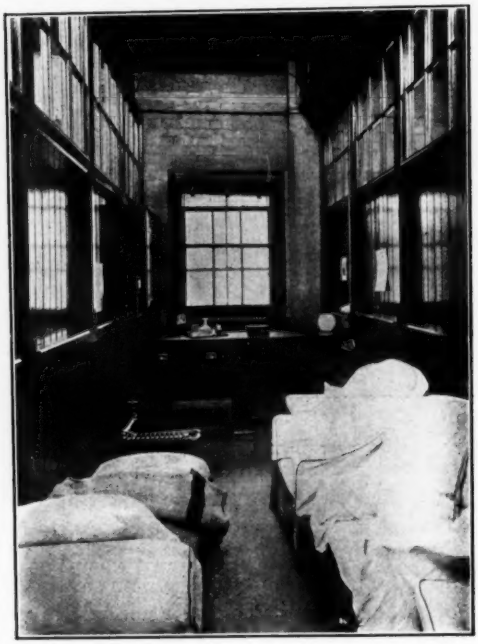
Of course it often happens that the illness is too great to allow of immediate restoration; and there may be serious accidents. In such cases there is all the more need for a place of retirement while temporary relief is administered and arrangements are made for the removal of the sufferer. Under such circumstances the lack of a place of this sort is embarrassing, to say the least. A woman is no less modest because she works in a factory, and it is proper that her modesty should be respected as much as possible, even in emergencies.

EMERGENCY ROOM IN A NEWLY BUILT AMERICAN FOUNDRY.
The B. F. Sturtevant Co., Hyde Park, Mass.

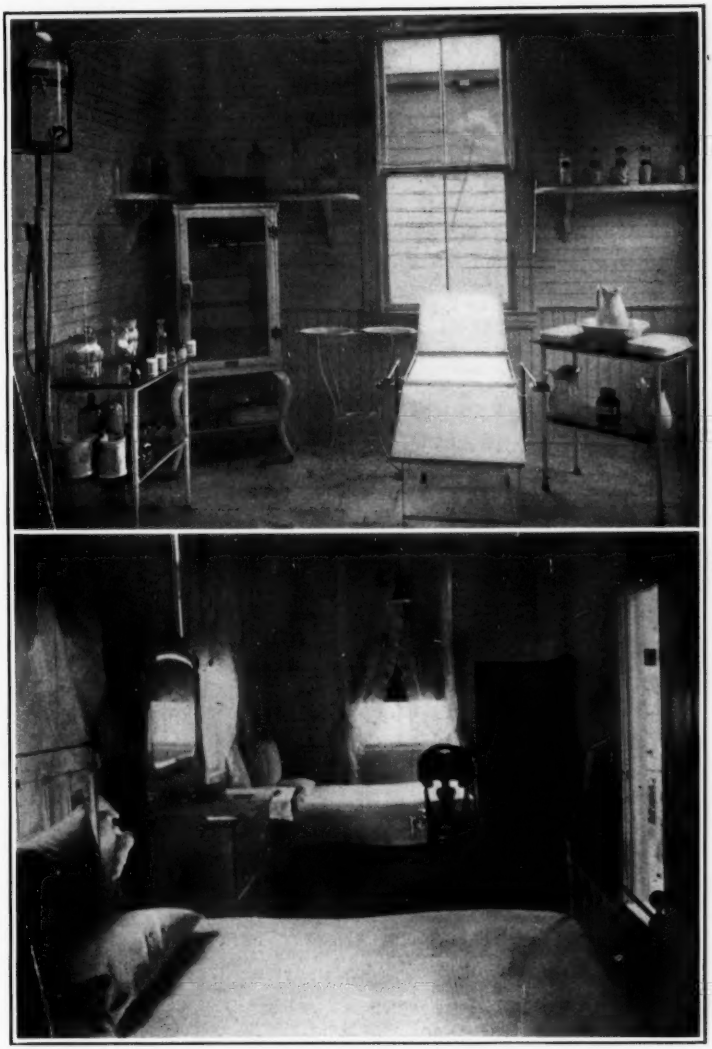
Caring for the injured and sick in a large plant is a matter of considerable importance, whether looked at from the humanitarian or the business point of view. The growing tendency of courts and juries to hold employers liable for damages in case of injury to the employee makes the annual payments in injury claims no small item. It is therefore a matter of economy for the employer not only to take all possible precautions, but to make ample provision for the care of their injured, if not of their sick. There are bound to be many small injuries in a large establishment, no matter how many safety devices

RECEPTION ROOM IN A FACTORY EMERGENCY HOSPITAL.
American Sheet and Tin Plate Co., Vandergrift, Pa.

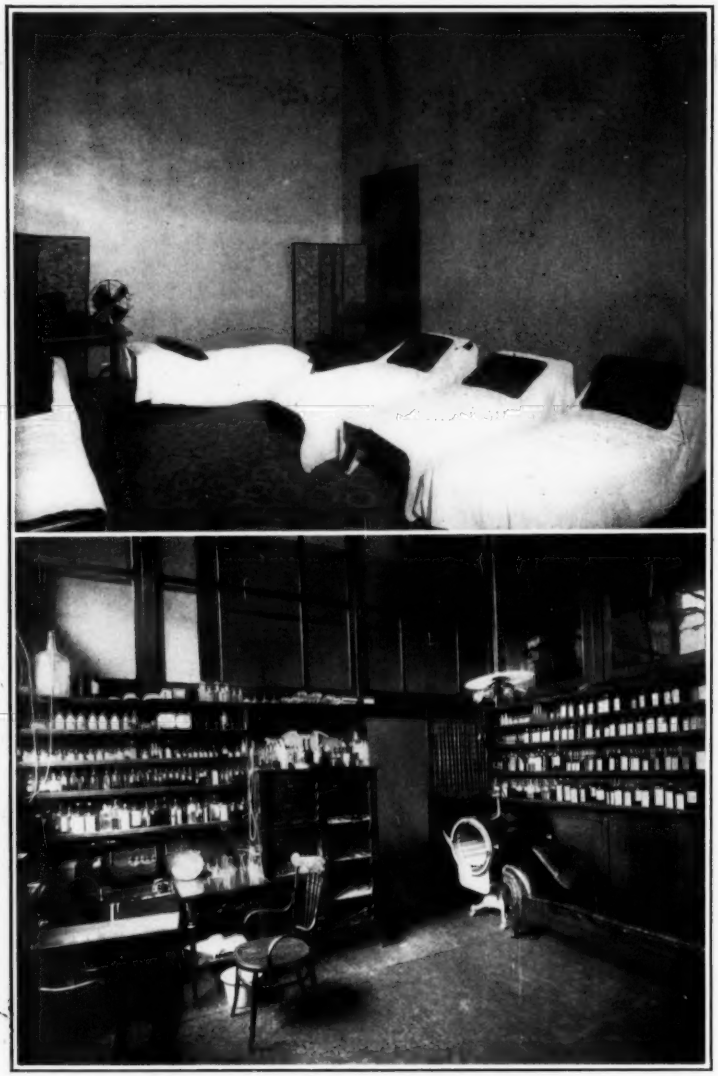
are in use, and no matter how small an injury may be, there is always a possibility of its becoming infected and leading to serious results unless promptly and properly treated. Emergency relief therefore is important from considerations of business economy as well as altruism. In Europe there is a wide-spread interest in the subject of first aid to the injured, cultivated in part, no doubt, by the stringent employers'-liability laws. There the knowledge of what to do in emergencies is not confined to physicians and to a very few laymen. Working people generally have become educated on this subject so that there is always some one at hand in case of emergency to take proper precautions and often thereby to save a life. In the United States the same subject is now receiving considerable attention, and a movement has



A RETIRING ROOM FOR GIRLS WORKING IN A SHOP.
Bourneville, England. The smaller wall cabinet on the left is stored with supplies for emergency relief.



OPERATING ROOM AND BEDROOM CONNECTED WITH A LARGE ENGINEERING WORKS.
The appliances include everything necessary for emergency operations. Serious cases are removed to a hospital as quickly as possible. American Sheet and Tin Plate Company, Vandergrift, Pa.



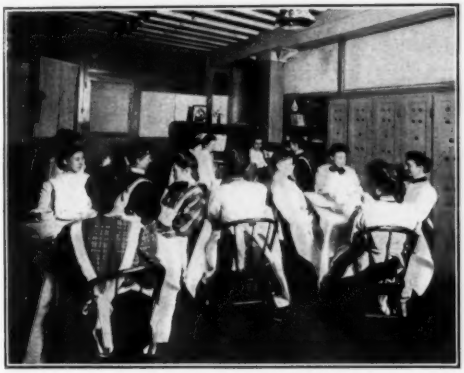
DOCTOR'S OFFICE AND DISPENSARY, AND SICK ROOM IN A LARGE DEPARTMENT STORE.
The Siegel-Cooper Co., N. Y.

A FACTORY WOMEN'S CLUB.
Lowe Brothers Company, Dayton, Ohio.

been set on foot looking toward the education of the masses in this important respect.

The employer, whether of many or few people, certainly owes it to himself and his business interests, as well as to those employees, to encourage such education. Many are already doing so. It is not uncommon to find in an establishment one or more persons who have some knowledge and skill in the first care of injuries—enough to give attention to injuries until a surgeon could be reached, should that be needful. Of course the first-aid man should have within reach a store of emergency supplies. The plan in vogue in some houses is to have suitable cases filled with necessary bandages, antiseptics, and other supplies in several parts of the works convenient of access.

It is usually desirable, particularly when there are no workmen with sufficient knowledge or experience to do such work, to give instructions in the subject. Where there is a house physician employed, or the employer has a contract with near-by surgeons, there is no difficulty in having the first-aid corps properly instructed and directed. They will naturally report to, and be under the instruction of, such physician. In those cases where there is no physician or competent director for such work, classes are organized, usually open to all who care to enter



WORKING GIRLS AT LUNCH.
Lowe Brothers Company, Dayton, Ohio.

SITTING ROOM AND NURSES OFFICE IN AN ENGLISH FACTORY.
Cadbury Brothers, Bourneville.

them, instructed by some one employed for that definite purpose. This is a very common course in England and Germany. In a short time the members of the class acquire sufficient skill to be entrusted with the preliminary care of the sick and injured. In small establishments this is about as much as can be expected, in addition to calling in a physician in serious cases.

Many concerns employ nurses or matrons, part of whose duties consist in this kind of work among the other women employees. In some instances this function is extended, and visits are made to the homes of those who are sick or absent from work. Working in connection with and under the direction of a house physician, this form of social service becomes of great value to employees, and employer as well. One great Chicago factory employs a visiting nurse for this purpose, in addition to two physicians and several matrons.

When the business is large enough to warrant the expense, the establishment of an emergency hospital in charge of a thoroughly qualified physician is almost of prime importance, and there are now a considerable number of these. They are usually equipped with modern hospital appliances and an ample dispensary, so that patients may be sure of receiving proper attention. As to the further manage-

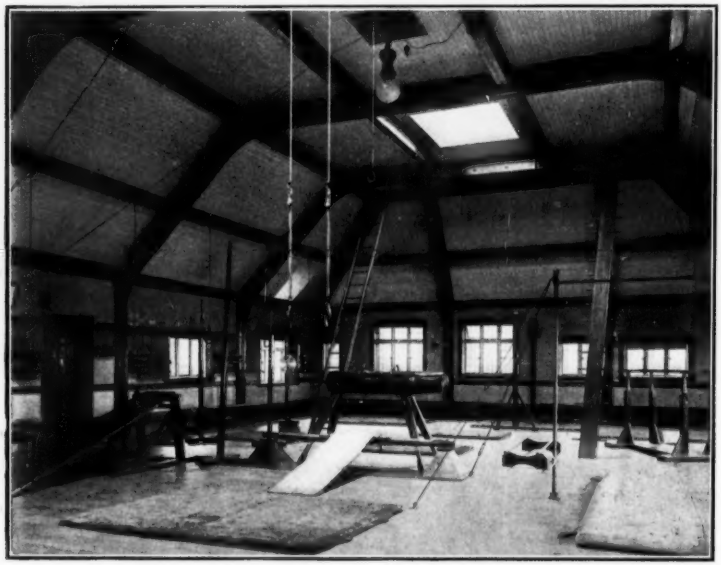
ment of cases, whether of sickness or of injury, practice varies. In some instances it is the custom to follow up every case and treat it in the patient's home or at the hospital (when desirable or necessary) with which arrangements have been made for the reception of the patients. Some large employers, notably the great railway systems, have their own hospitals, usually supported in part by the contributions of the employees. An interesting development of the emergency hospital idea is the hospital car lately put into service on the Southern Pacific Railroad.

Illness often arises, particularly among girls, from a cause usually not suspected. A case in point is that of a large employer of women who found that there was an alarming number of the girls leaving their work every day because of fainting spells or sudden illness. Upon careful investigation it was found that there could be but one reason for it—the long continued and close application to their work. It was decided to give them a short rest period at the middle of each half-day period. When this was done the trouble at once disappeared.

In some shops it is customary to make use of such periods of relaxation for simple calisthenic exercises which bring into play the

RELAXATION CALISTHENICS IN THE MIDDLE OF A WORK PERIOD.
National Cash Register Co.

muscles little used while at work, and relax the strain upon others. The girls then continue their work very much relieved. Such relaxation is especially desirable where the operatives have comparatively little freedom of movement or sit at their work. In some department stores as well as in other places of employment gymnasia have been fitted up for women, and occasionally also for men. The intention is that employees shall take a little time during the day, or at its close, to relax or limber up. Such places are undoubtedly useful; but unless the employees have a specifically allotted time, and are at that time under the direction of a gymnastic instructor, the gymnasia are found to be little used. What is necessary is, not elaborate rooms and equipment, but actual change in position and occupation for a few minutes, for all who do not get variety of muscular activity in their regular work. The work room is as likely as not to offer opportunity for this. There should always, however, be some one competent to do so, to lead the exercises. Otherwise there will be none.



INTERIOR OF MEN'S GYMNASIUM IN AN ENGLISH FACTORY.
A similar room is provided for women employees. Cadbury Brothers, Bourneville.

The productiveness of the worker, as has been already shown, depends very largely upon the nature of his environment in respect to those things that may be called the decencies, and those other things

that look toward the conservation of his health and strength. There is one other factor of real importance, a factor that is all but universally overlooked or neglected, namely that of the environment in respect to the æsthetic nature. Doubtless there will be incredulous smiles among readers of these words. This factor nevertheless deserves much more consideration than it usually receives.

A PRACICAL AND PLEASANT WORKROOM FOR WOMEN.
Color-card room in the paint factories of Lowe Brothers Company, Dayton, Ohio.

Attention has already been directed to the certain effect of slovenly shop surroundings upon the workmen in it. Good light, cleanliness, proper sanitation, comfortable position while at work—these and other things have been indicated as helpful in making workmen cheerful, happy, and content. But a shop may have all these things and still be a dismal, cheerless place to work in, whose depressing influence cannot be entirely dissipated by the lively activity of which it is the daily scene. It is doubtless too much to suggest, at least under prevailing industrial conditions, that every place where men and women work should be made beautiful. The manager of a foundry or a rolling mill would very likely laugh outright at the idea of beautifying such places. Commonly located in busy, crowded, and dirty districts, gridded with railroad tracks and switch yards, the buildings as tall and close to each other as possible and frequently hidden in clouds of smoke and dust,

the average factory looks very unpromising indeed from the æsthetic point of view. Experience has shown, however, that even under most discouraging conditions there are possibilities. The largest factory in its line in the world was ten years ago no exception to the general rule. Today it is throughout almost a work of art, internally as well as externally. The walls are painted, the newer buildings artistically designed, and old ones more or less reconstructed, vacant spaces not

A FACTORY ROOF GARDEN—A SUGGESTION OF WIDE APPLICABILITY.
Factory of the H. J. Heinz Co., Pittsburg, Pa.

otherwise utilized sodded with grass, shop walls agreeably tinted and at intervals hung with pictures and appropriate mottoes. Shrubs and vines are everywhere in evidence, boxes of plants and flowers grace many a window, and trees are found where least expected. The whole atmosphere is more that of a studio than that of a factory as ordinarily known. And the owner asserts most emphatically that all this, along with the many other agreeable conditions he has brought about, has a powerful influence upon his operatives, making them better men and women and better producers; and in consequence that it yields good interest upon the investment.

There is no inherent reason why such conditions should not ultimately prevail very largely, or even universally. The further development of mechanical methods of manipulating materials will assist greatly in bringing about such a changed condition. The use of

GROUNDS AND BUILDINGS OF A MODEL FACTORY.

The east lawn "Ivorydale" (the factories of the Procter & Gamble Co., Cincinnati) on "Dividend Day," the occasion of the quarterly profit-sharing distribution. The key to the Ivorydale policy is the effort to enable the employees to better themselves financially.

mechanical and automatic stokers in boiler rooms is a pertinent illustration. There are others equally to the point. Furthermore there is a distinct movement, much more marked at the present time in Europe than in the United States, to the location of manufactories and their

work people in so-called "garden cities." That is, to establish factories in the country, where land is comparatively cheap, use space freely for the housing of the work people as well as for the productive activities, and make the surroundings as attractive as may be. Doubtless this movement will continue to grow until, a better system of industrial economics having been generally accepted, the congested factory district of the large city will be less in evidence than now. In the meantime it is worth while to make the best of present conditions.

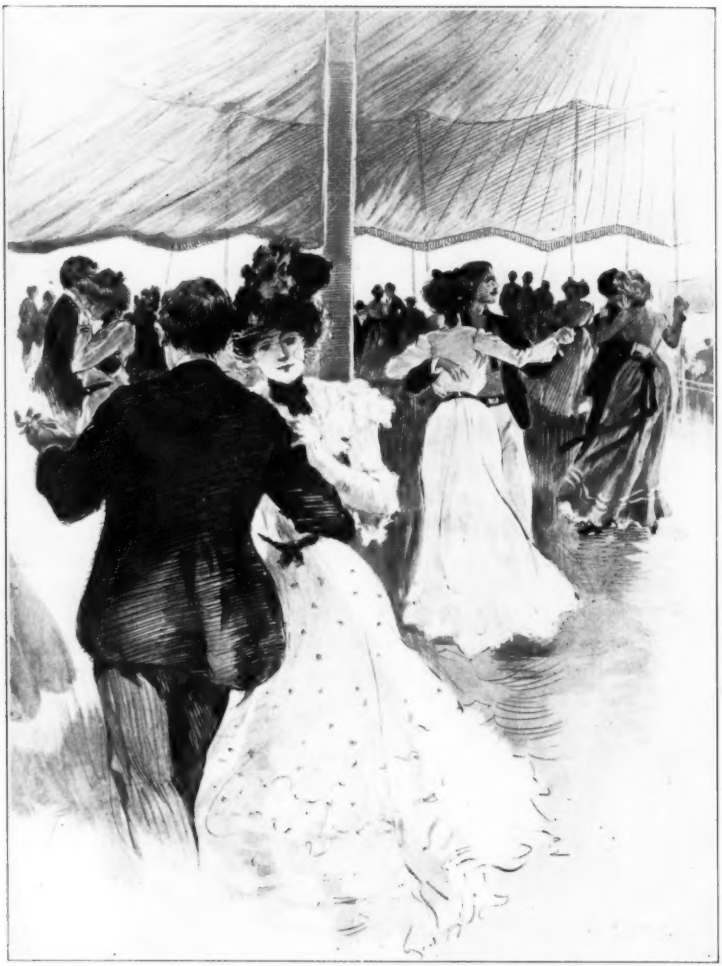
In every place, even in a factory, there are men and women who give a touch of their own personality to the little corner in which they may happen to work. If, fortunately, the person in charge of the work room be of such a nature, the whole shop takes on an atmosphere that markedly differentiates it from the others in the factory. Very likely no great change is made, no large thing done. Quite likely none of the employer's money is spent. But somehow the place looks different; it has an individuality that others lack. Perhaps it is only more neat and tidy; possibly a little picture, more than likely without a frame, lends a touch of color or repose to the walls; may be it is a pot or box of plants in bloom in the window. The place will be fairly radiant with cheerfulness, and everybody will want to sing or whistle at his

"FIELD DAY"—TYPICAL OF AN INSTITUTION FOUND IN MANY FACTORIES.
The view shows athletic sports of the Ludlow Manufacturing Associates.

ATHLETICS ON AN EMPLOYEES' PICNIC DAY.
Acme White Lead & Oil Co., Detroit, Mich.

work. And why should not people sing and whistle at their work? It is one of the surest evidences we have of cheerfulness and happiness; and if outward surroundings or internal exhilaration makes a man want to express his joy in music and work, what good reason exists for repressing one of the two modes of expression? Men ought to want to sing at their work, and they would, if happy and free to do so. But the depressing influence of average shop conditions is enough to drown the poesy and joy in almost any nature. It is a satisfaction to reflect that there are very few shops indeed that cannot be made tolerably attractive and pleasant, if the proper effort be but made. Nor is it necessary for the shop owner to go to large expense. A very little encouragement of the interested ones, and a little more example set by the management, will go a long way toward making work rooms pleasant.

One thing more remains to be considered in connection with proper working conditions in all places where women are employed, namely, the supervision of female workers by women. The frightfully immoral conditions that have existed, and unfortunately are not yet so rare as they should be, in work places where both sexes work together, are in large measure the result of placing young girls at work among men without throwing around them any sort of protection or affording them opportunity even to talk in confidence with an experienced woman competent to give sound advice. In departments where the



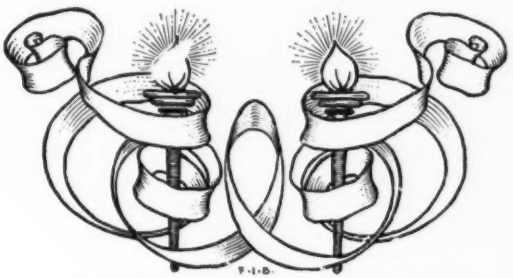
THE DANCING PAVILION ON "DIVIDEND DAY."
Factories of the Procter & Gamble Co., Ivorydale, Ohio.

workers are all women there would seem to be no legitimate reason why competent women could not be found to direct the workers. It is not essential that such a forewoman have charge of men workers, or even that she be independent of a general foreman. Indeed, it is found that a female assistant to the foreman, charged with the supervision

BILLIARD ROOM FOR EMPLOYEES.

Club House, McCormick Works of the International Harvester Co., Chicago.

of the girls, is a satisfactory arrangement. A woman supervisor or matron, not charged with responsibility for production, but to whom a group of girls, possibly the whole feminine working force, is responsible in things not immediately concerning their work, takes the place of the forewoman in some factories. In some instances such an arrangement is even better than the former, particularly if it be impracticable to have both a matron and a forewoman. The mere presence of a woman of broad sympathies and strong character among the women of an industrial or commercial establishment is enough to create and maintain an atmosphere of decency. Her usefulness will, however, in large measure depend upon the extent to which the management will co-operate with her in eliminating undesirable characters and the preservation of conditions conducive to decency and modesty.



SPEED CHARACTERISTICS AND THE CONTROL OF ELECTRIC MOTORS.

By Charles F. Scott.

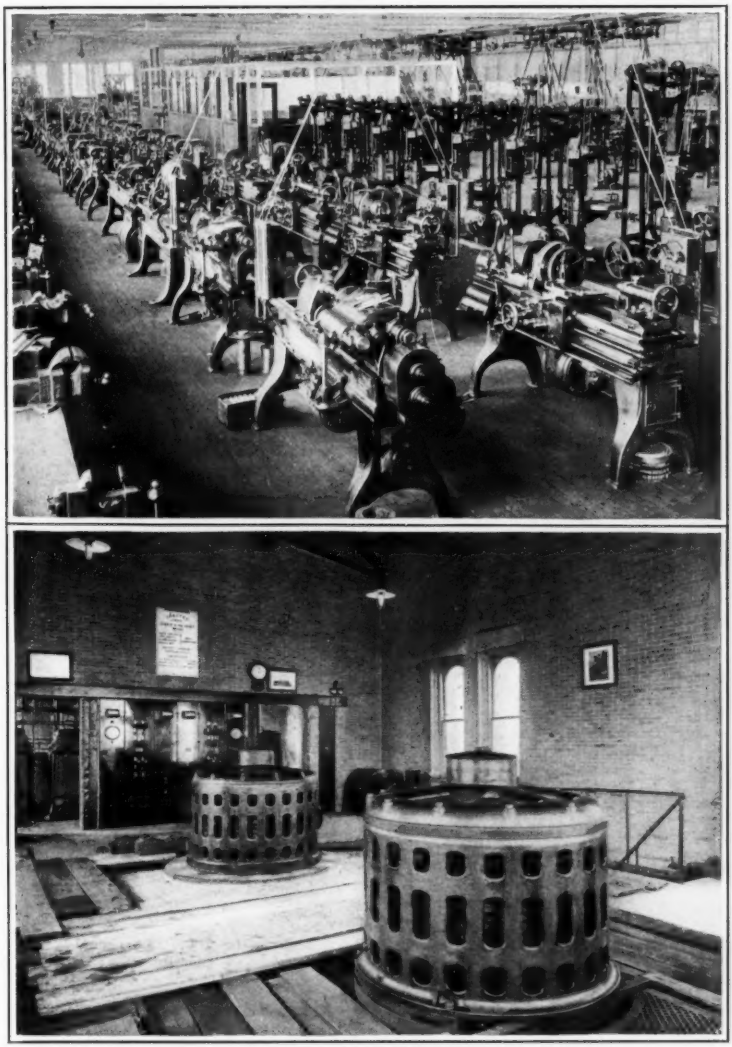
Mr. Scott, as President of the American Institute of Electrical Engineers, as well as by his professional work, has achieved an international reputation. In this paper and a second one, to follow next month, he gives a plain, practical synopsis of the various methods of speed variation for electric motors, adapted to put the subject at the complete command of the engineer interested in the use or operation of electric-driven machinery; and thus he shows how to widen the range of electric-power uses.—THE EDITORS.

ONE evening a few years ago I visited one of the largest steel mills in Pittsburg. A great ladle holding fifty tons of molten steel was lifted and carried quietly and quickly some little distance, and was then adjusted for pouring the steel into ingots. There were but few men in sight, and they seemed to have no connection with the moving mass of white-hot metal. Amid the occasional flaming of furnaces and the deep shadows of the weird scene, I discovered a man in a cage at one end of a high crane who was operating some levers. A few minutes later, in passing from one building to another, it was necessary to stand aside while a number of laborers passed, each carrying an ordinary plank. Each of these men was working harder in transporting a board than the operator of the crane in manipulating his ladle of steel.

It requires incidents such as this to make us realize what remarkable things the electric motor is doing, as its ordinary performances are becoming quite commonplace.

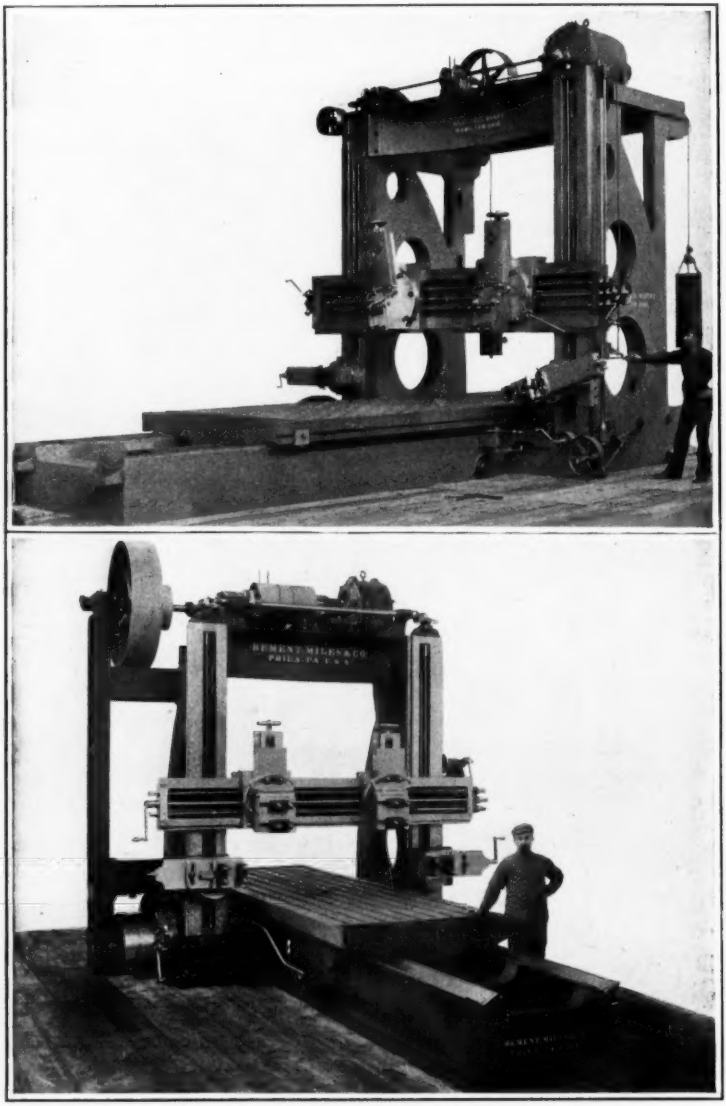
The application of electricity produces two kinds of types of effects. In the first place, the same results which were accomplished by former methods may often be secured at a reduced cost and with greater convenience. For example, the power from an engine may be transmitted to a large number of small sections of shafting in an extensive factory more readily by a system of dynamos, wires, and motors, than by belts and long shafting. The same engine in both cases may drive the same tools at the same speed.

In the second place, new results may be secured through the use of electricity. In fact as a general result, its introduction leads to new methods which secure a greater output and increased excellence. The introduction of the motor into the machine shop has resulted in new



RECENT INSTALLATIONS OF ELECTRICALLY OPERATED MACHINERY.

The upper view shows lathes in the West Lynn Works of the General Electric Company—an illustration of the fine illumination, compactness, and neatness of this mode of operation. The lower shows vertical-shaft induction motors driving 12,000,000 gallon centrifugal pumps. Rotterdam station, Schenectady water works. General Electric Company's motors.

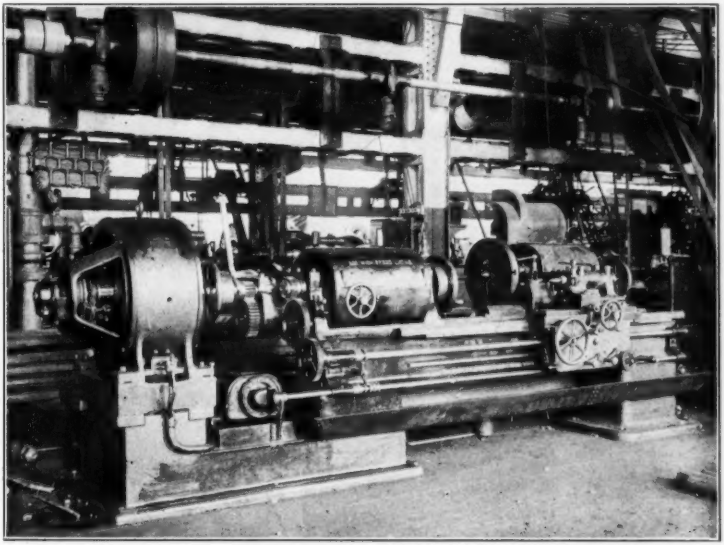


TWO EXAMPLES OF HEAVY PLANERS, ELECTRICALLY DRIVEN.

The upper one is made by the Niles-Bement-Pond Co.; the lower by Bement, Miles & Co
Both are operated by Westinghouse motors.

methods of applying power and controlling it, which have not only increased the output of the tool but have reacted upon its design so that new methods have been worked out, leading to radical advances.

As long as the reasons for adopting electric transmission in factories were limited to improvements in the transmission system it did not have a very attractive future. The total cost of supplying power in many large factories is but a small per cent of the total cost of manufacture. It was difficult, therefore, for the electric motor to make much headway when its field was limited to reductions in the cost of an item which was but four or five per cent of the total.

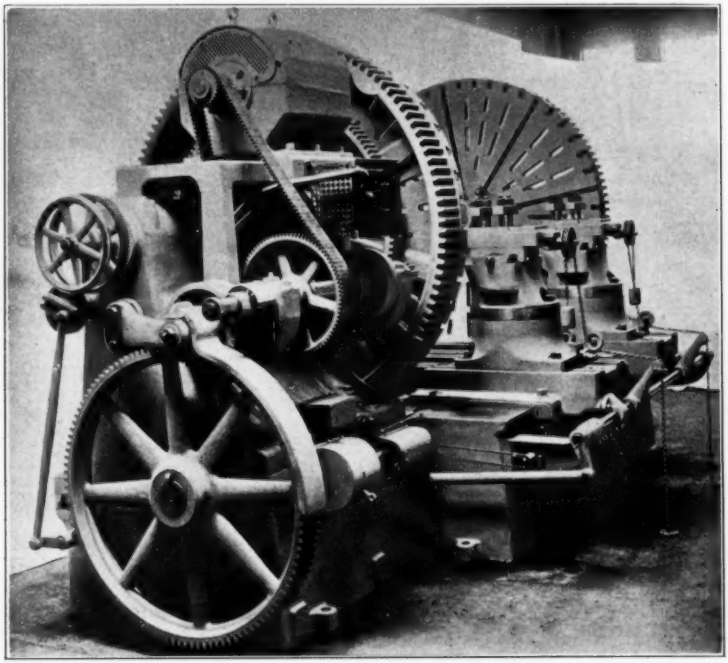


AN EXAMPLE OF MACHINE-TOOL PRACTICE AS MODIFIED BY ELECTRIC POWER APPLICATIONS.
Lodge & Shipley high-speed lathe driven by Westinghouse electric motor.

On the other hand, when it was appreciated that the motor, by means of its speed adjustment and other characteristics, could increase output, improve products, and materially reduce labor cost, then the real usefulness of the motor was recognized. The motor is useful not because it reduces power demands, but because it enables greater power to be used effectively.

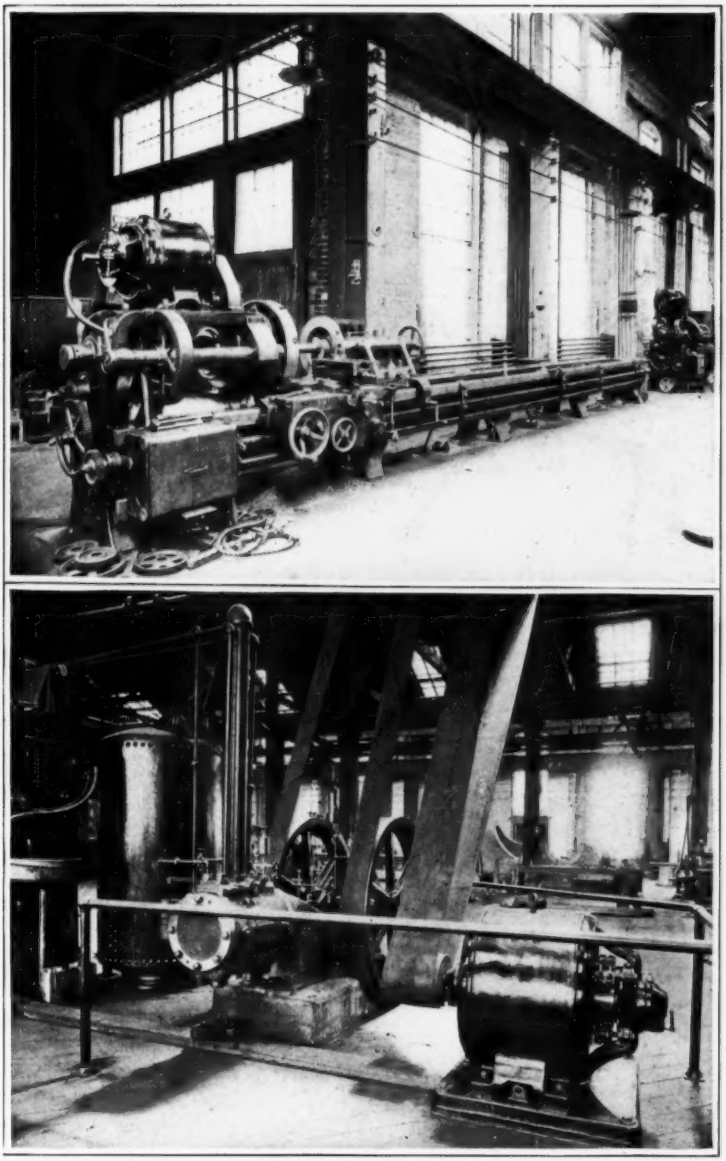
The rapidity of the changes which have taken place in machine-shop practice, most of which are closely associated with the electric motor, is one of the striking features in recent mechanical and electrical development.

It is interesting to note that one of the principal features which makes the motor useful and successful is mechanical rather than electrical. This feature is speed control. The control of the application of power by which the speed may be varied is the problem involved. Mechanical devices have been found wanting. There is no simple, universal, mechanical method of efficiently and satisfactorily varying the speed. If a mechanical engineer desires to make speed changes other than the most simple kind, he is pretty sure to leave his own field and seek the solution of his problem in the electric motor.



PUTNAM LATHE DRIVEN THROUGH SILENT CHAIN BY GENERAL ELECTRIC MOTOR. Twenty-five-horse-power direct-current. Speed variable from 350 to 1,050 revolutions.

It is, therefore, the speed variation of the electric motor which is one of its most unique and important characteristics. It is the purpose of this paper to consider the speed characteristics of motors in general, and of several types in particular. From this the applicability of different types of motors to different kinds of service will be determined.

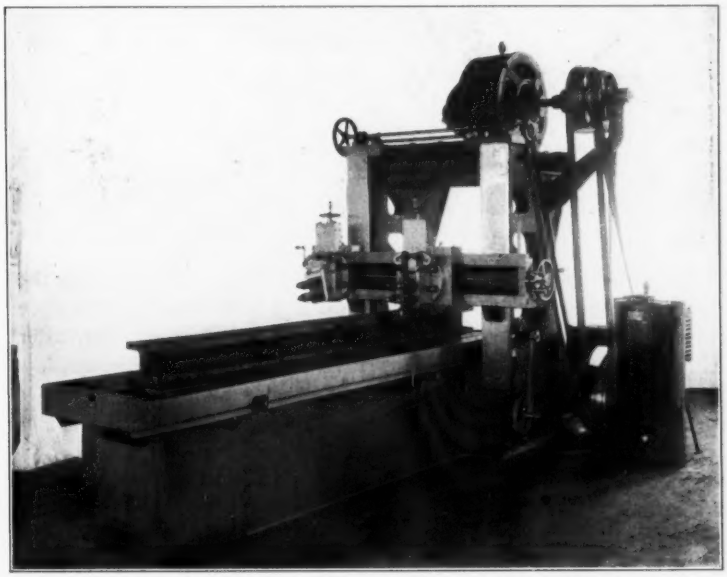


EXAMPLES OF MODERN ELECTRIC-MOTOR-DRIVEN MACHINE INSTALLATIONS.

The upper view shows lathes, and the lower an Ingersoll-Sergeant air compressor, all driven by Allis-Chalmers motors, in the shops of the Hooven, Owens, Rentschler Co., Hamilton, Ohio.

INDIVIDUAL-MOTOR INSTALLATION FOR ELECTRIC DRIVING OF MACHINE TOOLS, PITTSBURG & LAKE ERIE RAILROAD SHOPS.
Crocker-Wheeler motors, with multiple-voltage speed control.

The two factors which determine the rate at which work is being done are force and speed. Different designations are convenient for motors with rotating armatures—torque, or the force in pounds at one foot radius, (which is equal to the pull on a belt running on a pulley two feet in diameter), and speed in revolutions per minute. The mechanical performance of a motor is determined by these two elements, torque and speed. Its characteristics and its suitability for specific uses are dependent upon the relation between speed and torque.



WHITCOMB PLANER DRIVEN BY WESTINGHOUSE MOTOR.

A motor may run at constant speed with varying torque. Changes in load within the proper limits of capacity do not change the speed.

A motor may run at constant torque with varying speed. Such a motor geared to a pump would enable it to develop a constant pressure with varying volume, the latter varying with the speed.

A motor may develop different torques at different speeds. A familiar example is the railway motor, which runs slower up a grade where greater torque is required than is necessary on level track.

The interrelation of speed and torque may be shown on speed-torque curves. Several typical curves will be referred to in connection with the motors to which they apply.

WESTINGHOUSE MOTOR DRIVING CONCRETE MIXER AT THE EDGAR THOMSON STEEL WORKS.

It will be useful to consider in a more or less elementary way the electrical characteristics of motors upon which their speed-torque curves depend. Direct-current motors will be taken up first, after which several types of alternating-current motors will be discussed.

Direct-Current Motors.

A direct-current motor has two elements, a field and an armature. The field poles are surrounded by coils of wire. Current through these coils produces a magnetic field which passes through the armature. The armature rotating in the magnetic field has a pressure or electromotive force generated in it which may be measured at the brushes which rest on the commutator. This electromotive force is proportional to the field strength and to the speed. When the motor is connected with a supply circuit the speed will so adjust itself that the electromotive force produced in the armature corresponds to that of the supply circuit.

The speed of a motor depends upon:

(1) The field strength of the motor.

(2) The electromotive force, or voltage, applied to the armature.

A constant speed results, therefore, if the field strength and the voltage are constant, although the load may vary. A constant speed will likewise be secured if any decrease in either element is accompanied by a corresponding increase in the other.

A variable speed results from the variation of either element alone, or of both, provided the increase of one is not accompanied by a corresponding decrease in the second.

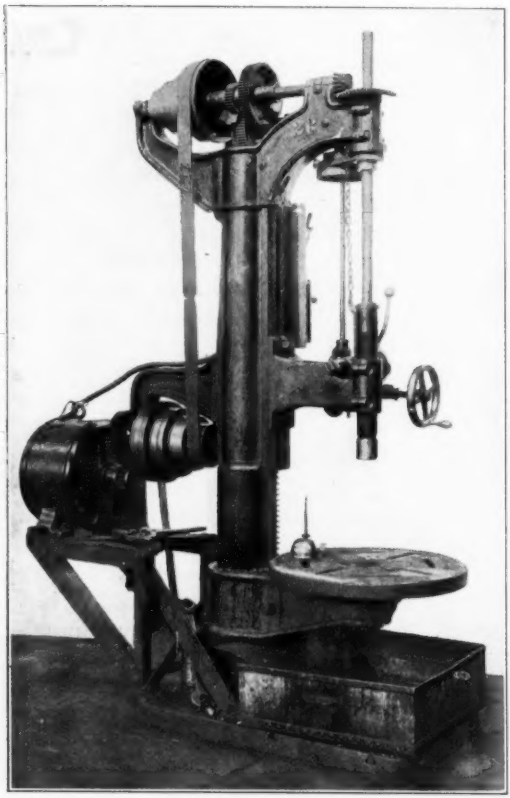
Variable speed is obtained in some cases by independent adjustment, in other cases automatically by the effect of change in load.

I. Speed Control by Field Strength.—There are several methods of varying the field strength, those commonly used being exemplified by the shunt, the compound, and the series motors.

(a) The shunt motor has its field winding connected to a constant-voltage supply circuit. Its current is therefore independent of the current to the commutator, as the two are connected in parallel. The speed is therefore independent of the load; the motor is inherently a constant-speed motor and changes must be effected by external means. The insertion of an adjustable resistance in series with the field circuit is a ready means of making such changes. The resistance reduces the current; this in turn reduces the strength of the magnetic field and an increase of speed results. If speed is to be adjustable, either above or below a certain normal, the motor is so designed that there is some resistance in the rheostat at normal speed, thus allowing for either increase or decrease.

If the field current at its new value remains constant, the motor has a new speed which it maintains independent of the load. This is quite an important matter. Although motors which are adjustable

ELECTRICALLY DRIVEN BENDING ROLLS, UNION PACIFIC RAILWAY SHOPS, OMAHA, NEB.
Niles machine and Westinghouse motor.

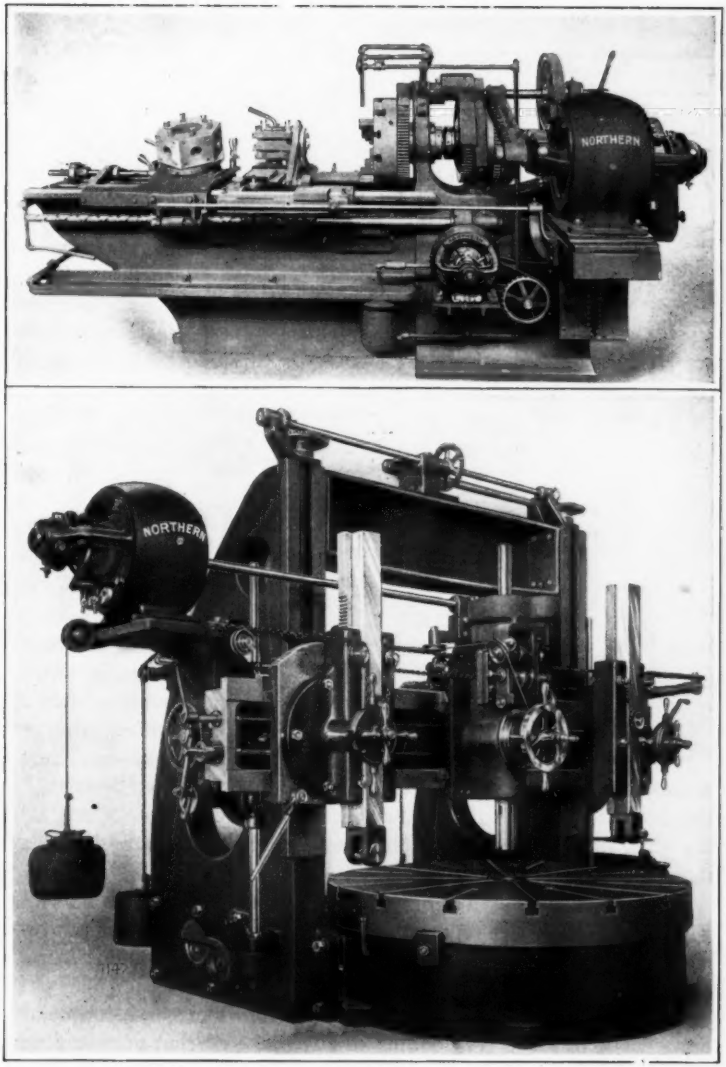


RADIAL DRILL OPERATED BY ALLIS-CHALMERS MOTOR.

in this manner for running at different speeds are in a general way termed "variable-speed" motors, they are really *adjustable-speed* motors, as they maintain with varying load the constant speed for which their rheostats are adjusted.

The practical limits of speed variation by this method of control depend upon the characteristics of the motor to which it is applied. It is rarely that a motor may not be varied over 5 per cent or 10 per cent, and motors may be designed for an increase of 100 per cent and even of 300 per cent of the minimum speed. Motors which have a wide variation are heavier than a motor designed for a single speed only. Some of the relations between capacity and speed variation will be taken up later on.

(b) The compound motor has two independent field windings. One is the shunt winding, which is connected to the circuit in a similar manner to the field winding of the simple shunt motor. The other is the series winding which carries the armature current. When there is no load the series winding is inactive; when there is load, the current passing to the armature through the series field is effective in proportion to the load. The current in the series field may pass



MODERN MACHINE TOOLS DRIVEN BY ELECTRIC MOTORS.

The top figure is a Gisholt turret lathe, with 5-horse-power Northern single-voltage variable-speed motor driving the spindle through silent chain, and small motor driving pump and turret mechanism. The lower one is a boring and turning mill, by the Betts Machine Co., Wilmington, Del., with 5-horse-power Northern motor (340-1,350 revolutions) driving the grinding spindle. Northern Electrical Mfg. Co.

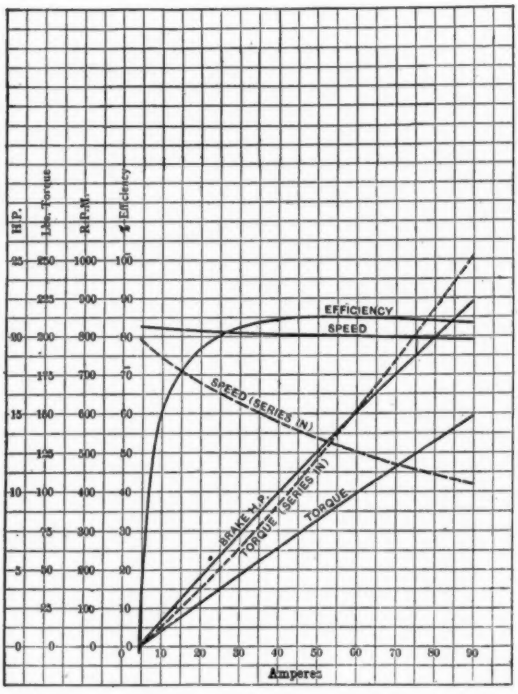


FIG. 1. TYPICAL CURVES FOR SHUNT AND COMPOUND MOTORS.

around the field poles in the same direction as the shunt current, or it may oppose it. In one case the field is strengthened and the speed becomes less; in the other the field is weakened and the speed becomes greater. Compound motors have a no-load speed which is fixed by the value of the shunt field current, and the speed is usually made to fall off from the no-load speed in approximate proportion to the load. The motor therefore becomes inherently a slower speed motor as the load is increased, or, stating it in a slightly different way, the motor runs at light load at a higher speed than at full load.

Typical curves for a shunt and a compound motor are shown in Figure 1. The curves representing the two types are taken from tests upon the same motor, first with the shunt winding only and then with the shunt and series windings both active.

The horizontal scale is plotted in amperes. The speed, torque and brake horse power corresponding to any given current may be found on the vertical line corresponding to that current. The heavy lines representing the performance of the shunt motor show that the torque and brake horse power are closely proportional to the armature current. These curves, however, strike the base line at approximately 4 amperes, this being the constant current in the shunt field. The

speed is approximately constant at about 800 revolutions per minute, falling slightly, however, with load. When the series coil is in commission the increased field strength causes the speed to fall off rapidly. The torque is correspondingly increased so that the brake horse power corresponding to a given current is very nearly the same as it is when the motor is running as a shunt motor. The very considerable increased torque at low speed is serviceable in those cases where large torque is required for starting and for accelerating, as, for example, in elevator service. When the motor has attained speed the series winding may be kept in circuit, or it may be cut out of circuit and the motor may run as a shunt motor.

(c) The series motor has its field winding connected in series with the armature. The current in its field varies directly with the current in the armature, and, therefore, increases with the load. If the load be lessened the current is reduced, the field strength is likewise reduced, and the speed increases. If the load be made very small the speed may become so high as to endanger the armature mechanically. It is therefore inadvisable to use the series motors if the load is liable to be very small. A compound motor with a strong series winding has nearly the same characteristics under load and has the safeguard of a definite maximum-speed limit. The series motor is

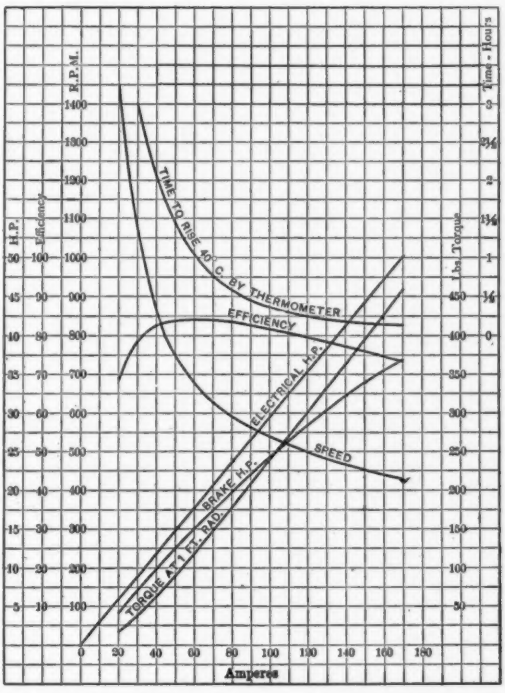
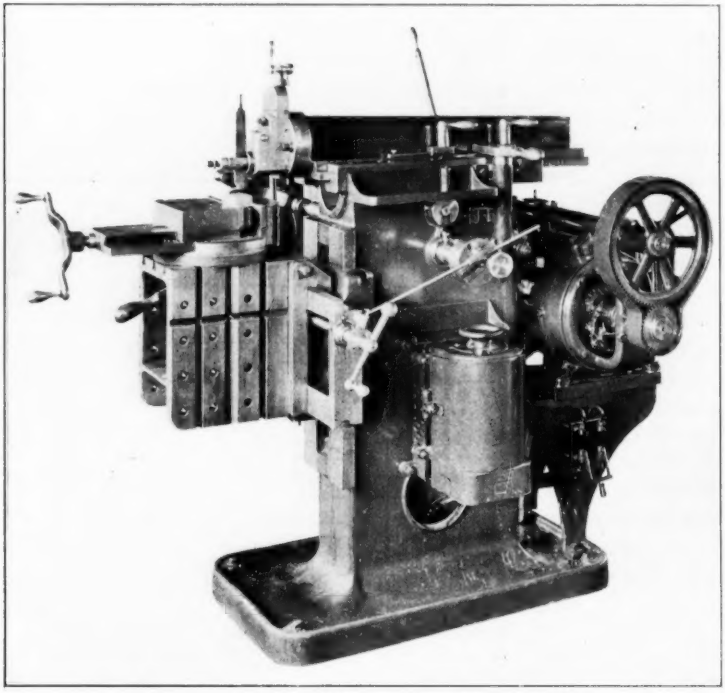


FIG. 2. CHARACTERISTIC CURVE FOR SERIES MOTOR.

used on street cars and locomotives and for cranes and hoists, where the motors are under the control of an operator.

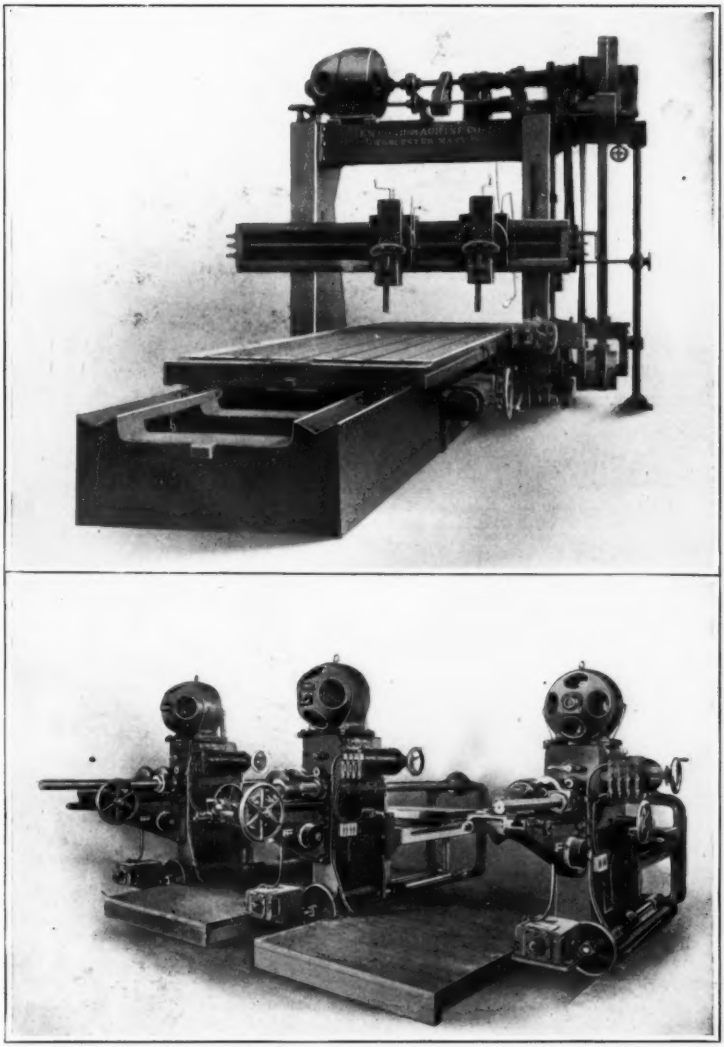
A characteristic curve for a series motor is given in Figure 2. The speed curve except at light load is approximately similar to that of the compound-wound motor. At light load when the current is relatively small, the speed, however, increases very considerably. The torque and brake horse power both increase as the current increases. The torque has an increasing rate while the brake horse power increases



GENERAL ELECTRIC MOTOR DRIVING A HENDY SHAPER.
Direct-current, one-horse-power, 500 to 1,500 revolutions.

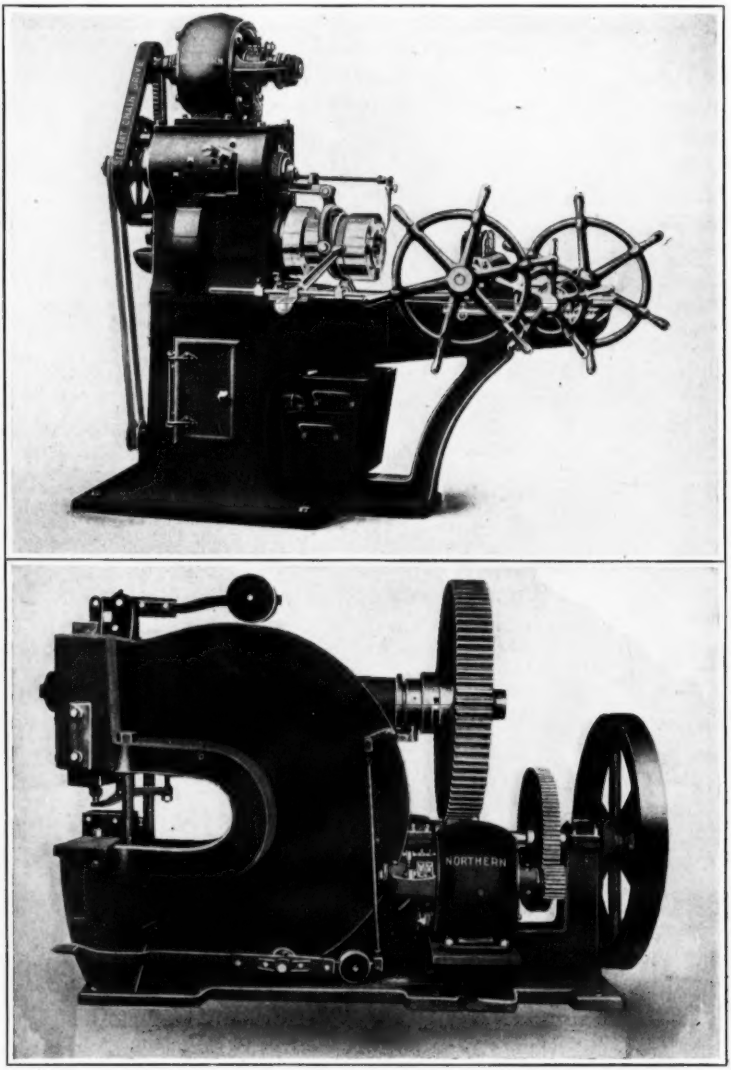
less rapidly than the current due to losses in the motor. If it were not for these losses the electrical horse power would increase in proportion to the current. The straight line representing the electrical horse power input shows that the power taken is proportional to the current, and the falling off in the output is therefore the result of the decreasing efficiency at greater loads.

II. Speed Control by Armature Voltage.—The speed of a motor



MODERN MACHINE TOOLS DRIVEN BY ELECTRIC MOTORS.

The upper illustration shows a planer by the L. W. Pond Machine Co., and the lower a group of horizontal boring and drilling machines by Bement, Miles & Co., all equipped with Crocker-Wheeler motors with multiple-voltage speed control.

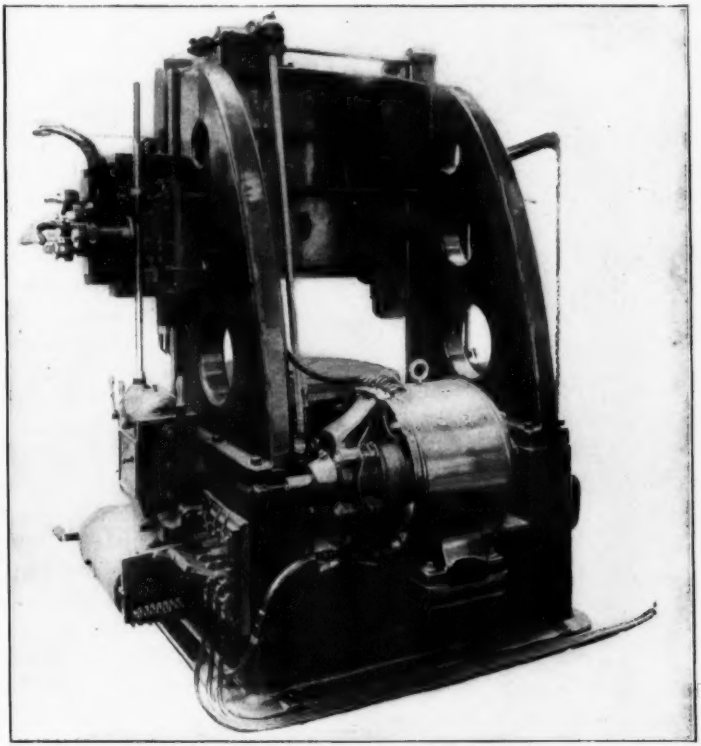


MODERN MACHINE TOOLS DRIVEN BY ELECTRIC MOTORS.

The upper figure shows a threading and cutting-off machine, by the National Machinery Co., Tiffin, Ohio, with Northern single-voltage variable-speed motor; the lower is a punch, by the Cincinnati Punch & Shear Co., with 7½-horse-power Northern spherical motor.

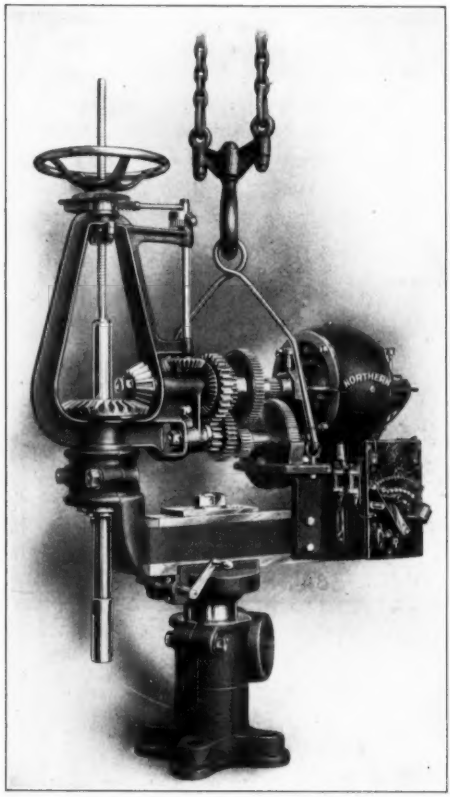
depends upon the electromotive force or voltage applied to its armature. There are several methods of varying the voltage applied to the armature. Some of these methods involve only the motor and its auxiliary apparatus, while others require special supply circuits.

(a) Control by armature resistance is a simple and convenient method. The resistance is placed in series with the armature circuit. The current suffers a loss of voltage in passing through the resistance.



KING BORING MILL DRIVEN BY ALLIS-CHALMERS MOTOR.

It follows, therefore, that the voltage delivered at the armature terminals is reduced by an amount dependent upon the value of the resistance and the quantity of current flowing. This method of control is commonly used for starting motors of all classes. If the motor were connected directly with the circuit for starting, the initial current would, in general, be very large. It is therefore suitably reduced by the resistance which is reduced step by step and is cut out entirely



ELECTRIC DRIVING OF A PORTABLE TOOL.
Northern Electrical Mfg. Co.'s spherical motor applied to portable drill built by Thos. R. Dallett & Co., Philadelphia.

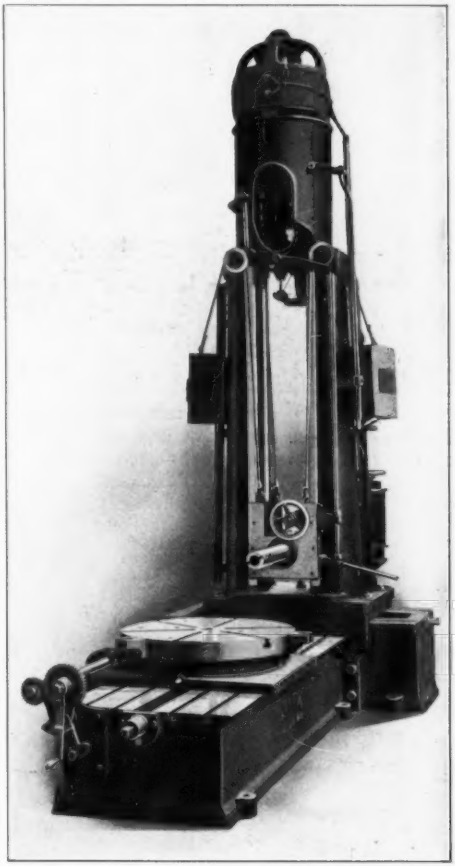
when the normal conditions of operation are reached.

As a shunt motor has its shunt field connected directly across the circuit, the field strength is independent of the armature resistance and armature current. If the field strength be kept constant the speed will, of course, be proportional to the armature voltage. The insertion of a given resistance in series with the armature will reduce the voltage on the armature by an amount dependent upon the strength of the current, and if with a certain load the reduction in voltage and in speed be, say 10 per cent, then an increase in the load which doubles the current will cause a reduction in voltage and in speed of 20 per cent. This example illustrates the character and principal limitation of this method of speed control—namely, that the speed varies with the load. This method is, therefore, quite unsuited to those applications where constancy of speed under varying load is essential. The loss of power in the resistance is likewise an objection to this method of control. The power which is delivered by the current passing through the resistance and armature divides in proportion to the electromotive forces. Thus, if the resistance absorbs 10 per cent of the electromotive force, it likewise absorbs 10 per cent of the energy, and the power delivered to the

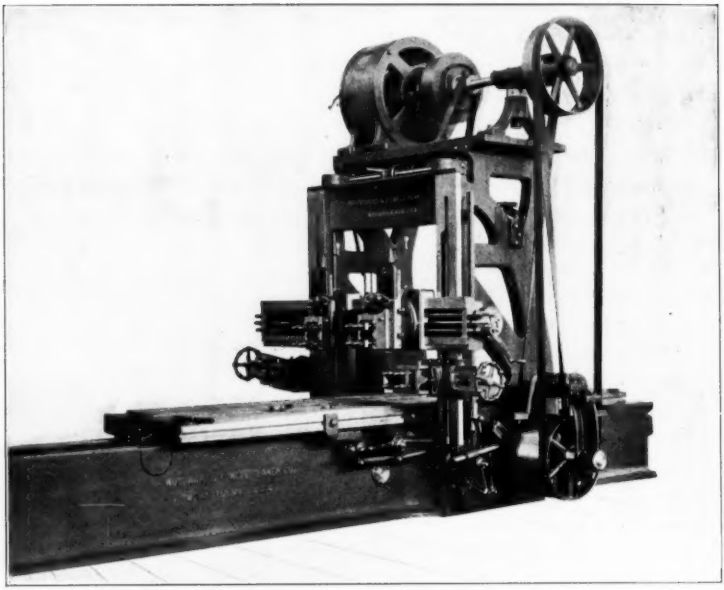
armature is 90 per cent. In general, the proportion of power delivered to the armature is in proportion to its speed. If the speed be reduced by the resistance to 70 per cent, the power received by the armature is 70 per cent.

Summarizing briefly the characteristics of this method of control as applied to shunt motors, the favorable points are low cost of apparatus, simplicity, applicability to standard motors, and wide range of speed variation; while the unfavorable points are low efficiency and the resulting higher cost of operation, unstable speed under varying conditions of load, and reduction of motor output at low speeds. There are, however, conditions under which the unfavorable characteristics have but little weight and in which the method may be advantageously employed. It may, for instance, be used in connection with a more efficient system of speed control to obtain lower speeds than could otherwise be secured, particularly if the service at these low speeds is intermittent.

(b) A variable voltage may be obtained from a special generator. In this case the generator may be conveniently driven by means of a motor and the voltage of the gen-

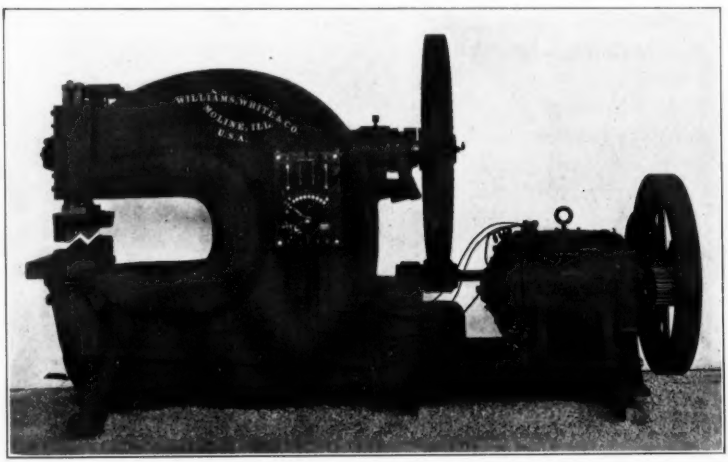


A SPECIAL ADAPTATION OF ELECTRIC DRIVING FOR A MACHINE TOOL.
Newton vertical milling and drilling machine with Crocker-Wheeler vertical motor; multiple-voltage speed control.



A RECENT ELECTRICALLY EQUIPPED LATHE.

Woodward & Powell machine, Westinghouse motor; 15-horse-power, direct-current, 575 to 1,150 revolutions; cutting speed of table 16 to 32 ft. per minute; return speed 3 to 1.



A LARGE SHEAR AND PUNCH DRIVEN BY WESTINGHOUSE MOTOR.

erator may be varied by a rheostat in its field circuit. This affords a means of supplying an adjustable definite voltage to the motor, which is practically independent of the current taken. In so far as the motor is concerned, the method is admirable. The objections to it lie in the inconvenience and cost of the motor-generator. It is, therefore, not suited for general adoption, although there are cases in which its advantages overcome the objectional features.

(c) The three-wire system, which, as commonly applied, has 220 volts between two of its wires and 110 volts between each of these and the middle wire. A motor may receive its armature current at either 220 volts or at 110 volts, the speed under the latter conditions being reduced to one-half. Two speeds, therefore, may be obtained in the ratio of 2:1, without the use of resistances and under conditions in which the voltage applied to the armature does not vary with the load. This method of control may be advantageously combined with control by variation of the field current of shunt motors. If the motor be so designed that it can operate from maximum speed to half-speed when running on 220 volts, it will when connected to a 110-volt circuit operate satisfactorily from one-half to one-fourth speed, thus giving a wide range of speed adjustment. A motor may be designed which may be controlled by its field strength over a wide range in speed, but its size and cost will exceed those of a motor having a range which is only half as great. The latter smaller motor may be given the greater range in speed if it has available the auxiliary half voltage which the three-wire system affords.

(d) A three-wire system with unequal voltages, for example, 80, 160 and 240 volts, affords somewhat greater flexibility in speed adjustment, in so far as the motor itself is concerned. The gain in having the maximum voltage divided into thirds, instead of halves, is not, however, a radical one, and some disadvantages are involved. The dynamos for generating the several voltages cannot be so conveniently arranged as those for two voltages. The amount of current to be delivered to the motor at one-third of the full voltage is greater for the development of a given power at low speed than that required at half voltage. The heavier current may be objectionable both on account of the increased size of conductor necessary between the generator and the motor, and also on account of the greater current which must be handled by the motor itself.

An additional number of voltages may be available by adopting the four-wire system, which will afford additional voltages between the several pairs of wires. This, however, involves greater complication

in the generating apparatus and transmission circuits and in the controller. It involves the use of larger currents at very slow speeds than is necessary in the three-wire system. The principal advantage in the use of a multi-voltage system, involving a considerable number of voltages, is that less range of speed is necessary in the field control.

(e) The double commutator motor is a further method of securing speed control. A motor may be provided with two windings and two commutators. The two windings may be identical, and each may be independently connected to the supply circuit; or the two commutators may be connected in series. In the latter case each commutator receives half of the circuit voltage and the speed, therefore, falls to one-half. This method is, in effect, quite similar to the operation of the ordinary motor on the three-wire system, whereby the armature may be supplied with either the full voltage or half voltage. Intermitttent speeds on the double-commutator motors may be obtained by control of the shunt field. The two armature windings, instead of being made equal, may be wound differently. One winding alone may give a certain speed, and the other above a lower speed, or the two windings may be connected in series either in opposition to give a maximum speed, or in the same direction for giving a minimum speed. Intermediate speeds may be obtained by variation of the shunt field current. This system secures a wide range of speed variation. It has, however, certain drawbacks in the complicated construction of both the motor and the controller. The double commutator motor is unusual and of special construction.

A comparison of the foregoing methods of speed control shows several points in favor of control by variation of the strength of the shunt field, when adjustable speeds are desired which shall be constant independent of load variations. The motor and control devices are simple. The supply circuit is of the simplest kind without special generators or additional wires. The current is always a minimum, as no low voltages are used which would require a greater current for a given power.

Speed, Torque, Voltage and Current.—The relations of speed and torque to output and to voltage and current will be apparent upon a consideration of the following relations.

Power is proportional to speed multiplied by torque.

Power is proportional to electromotive force multiplied by current.

If the electromotive force be constant, the speed is constant—therefore, the torque, horse power, and current vary together. If the

load be doubled, both the torque and current are doubled. Under these conditions, therefore, torque and current are proportional.

If the electromotive force applied to the armature be varied, the speed changes in a like proportion.

With a definite constant field strength the speed is proportional to the applied electromotive force, and the torque is proportional to the current.

If a motor running at constant voltage carry a load of such a character that the output in horse power is constant at different speeds, then, although the speed may be varied over a wide range, there will be no change in the current, for the reason that both the electromotive force and the output remain constant. Upon this fact depends an important feature in comparing different methods of speed control. If the speed of a motor is to be reduced to one-half, the reduction may be effected as has been pointed out, either by increasing the strength of the field or by reducing the electromotive force applied to the armature. If the speed change is made by changes in the field strength, then the current depends only on the power output and not upon the speed. If, for example, the power required involves a current of 10 amperes at 220 volts for the delivery of a given output, then the current taken from the circuit is the same whether the power be delivered at full-speed or half-speed. If, however, the electromotive force be reduced to half in order to effect the speed reduction, then the current will be doubled, or 20 amperes. The heavier current involves an increased loss in the transmisssion circuits, as well as requiring that a greater current be handled by the commutator and the armature conductors of the motor. It is, therefore, in general, desirable, both on account of the supply circuits and the motor itself, to employ a reasonably high electromotive force, particularly in those cases where the output at low speed may be considerable.

Limitations of Motors.—The characteristics of the motor which fix its limitations in operation form a useful basis for an understanding of the conditions under which it may be used.

(a) Variation of the field strength is a convenient method of speed control, but it has certain definite limitations. The increase in field strength is limited by the physical characteristics of iron and of copper. The iron, which constitutes the magnetic circuit of the motor, has a high permeability, and over a considerable range the magnetic field strength of the motor, varies in proportion to the current in the field coils. As the current is increased, however, the field becomes saturated and the increase in strength is not in proportion to the in-

crease in current. With very heavy currrents a very considerable increase in the field current causes but slight increase in the resulting magnetization. The current passing through the field winding heats the copper conductors. If the current be increased, the heating is likewise increased, but the increase is proportional to the square of the current. Consequently, double current results in four times the heating in the field coils. It will be readily seen, therefore, that as the field current is increased beyond certain limits, the magnetization increases but slightly, although the heating increases with great rapidity. If a motor is intended for operation at constant speed it is usual to proportion the field so that the iron is near saturation and the field coils will operate at a reasonable temperature. On the other hand, if the motor is to operate at a variable speed, to be controlled by the field current, the proportions of the magnetic circuit and the coils are made such as to admit of such an increase in current and magnetization above that required for full speed as may be necessary for operation at the lower speed. The two elements, therefore, which limit the range of field adjustment of a given motor are the saturation of its magnetic circuit and the heating of its field coils.

(b) The electromotive force applied to the armature, which is one of the elements by which speed control may be secured, has a certain maximum limit, depending upon the windings and the commutator design. This limit is usually somewhat above the normal conditions for which the motor is designed. The motor will handle satisfactorily any electromotive force lower than this provided the current is not excessive.

(c) The armature current, and consequently the motor output in horse power under given conditions of field strength and armature voltage, has its limitations in sparking at the commutator and heating of the conductors. The sparking and the general behavior of the commutator depend primarily upon the current strength and also upon the strength of the field. Commutation is much better when the magnetic field of the motor is strong than it is when the field is weak. This is a characteristic which must be taken into account by the designer of the motor. In operation it will generally be found that there is less tendency to sparking with a greater field currrent, consequently a reduced speed secured through increase in field strength enables a greater current to be satisfactorily commutated. On the other hand, a small field current which is incident to a high speed, gives conditions which place the commutation limit at a low value of the armature current. To overcome this limitation small auxiliary field poles may be

introduced between the regular poles. The auxiliary poles have windings through which the current from the armature passes. The magnetic field from these poles supplies a local field which facilitates commutation and thereby greatly extends the speed range over which successful commutation can be secured.

The second limitation in armature current is temperature. The heating in the armature conductors is proportional to the square of current flowing. An increase in load, therefore, increases the heating at a rapid rate. An increase of 50 per cent in current more than doubles the heating in the armature conductors. It causes also a like increase in the heat developed in the brushes and brush holders. Heat is developed in the iron core of the armature. This varies with the field strength. With heavy field currents for producing low speeds the heat due to this cause is therefore greater than at high speeds.

The horse-power output of a motor is approximately proportional to the product of electromotive force and current; hence if the voltage be constant and the temperature limits fix the current at a definite number of amperes, then the safe input is independent of the speed and the safe output is the same in horse power at all speeds. This meets the requirement of many machine tools, which use approximately the same power at all speeds. On the other hand, if the method of speed control employed involves the application of different electromotive forces to the armature, the safe horse power output will be less at low voltage, as the allowable current gives less power at the lower voltage.

(d) There is also a mechanical limit to the armature speed above which there is liability to accident.

From the foregoing conditions regarding the limitations of the electric motor, it is seen that the principal limitations in service are commutation and temperature. The temperature limitation is one which is not definite and fixed. If the load be too great for a belt the belt slips; if the load be too great for a water wheel or an engine it slows down or stops. But if a motor be overloaded there will in some cases be a decrease in speed, and in other cases a danger indication at the commutator, but in general it will keep steadily at work, although the temperature may increase considerably. The temperature may rise beyond proper limits, but without giving immediate indication, and, in fact, it is difficult to determine whether the actual temperatures are safe. The effects of high temperature may not manifest themselves at once but may result in a slow charing of the insulation, which may not be detected until the damage has been done. In general,

therefore, motors should receive a degree of reasonable intelligent supervision to prevent overloading, which may be unnecessary with other types of apparatus which have more prompt and emphatic methods of indicating when their proper limits are exceeded.

The temperature of a motor which is in continuous service at constant load depends upon the rate at which heat is generated in the motor and the rate at which it is dissipated. If, however, a motor is subjected to intermittent service the operation of heavy loads is an important factor. It is obvious that the motor which could carry 10 horse power continuously might carry considerable greater loads for short intervals without exceeding the same temperature limits. As the variety of load conditions to which a motor may be subjected is infinite, it is impossible on the one hand to lay out any very definite rules covering the variable service of motors. On the other hand, it is rarely the case that the variable conditions are definitely known. The average load upon the crane or machine tool and the proportion of time during an hour or a day during which the load will be heavy depends upon service conditions, which cannot usually be definitely foretold. In the selection of a motor there is liability either of installing a motor which is larger than necesssary or of selecting one which is too small. The capacity of the motor may be specified by the length of time which it requires to rise a given amount in temperature under different conditions of load. Such a safe temperature curve is given in Figure 2, which shows that the motor may run for several hours at a light load before attaining a temperature which would be reached in 10 minutes at heavy load.

In the foregoing considerations regarding motors, general principles have been discussed, and a number of secondary and minor features have not been taken into consideration. For example, the speed of a motor with constant field strength and constant armature voltage is usually not constant, but falls off slightly with load; again the product of electromotive force and current supplied to the armature of motor is not an exact measure of the power developed, on account of the losses between the electrical terminals and the pulley. These vary in different motors, and it would simply lead to confusion to endeavor to consider them fully in a paper of the present general character.

The consideration of alternating-current motors with respect to their speed characteristics and control is reserved for a following paper.

THE BETTERMENT OF POWER-STATION ECONOMY BY ELECTRIC AUXILIARIES.

By Arthur S. Mann.

The importance of the subject of auxiliaries is not always fully appreciated, and too often these necessary adjuncts are neglected, while the greatest care is given to the economical performance of the main engines. Power-house engineers may well consider the experience which has been attained in this matter by marine engineers and by the engineers of the great textile mills, where the final efficiency of the whole plant in money is the only thing which is allowed to count. The practice of drawing steam from the receiver of compound engines for use in heating water has been found advantageous in many cases in factory practice, while in some instances in marine service it has been found economical to have the steam-driven auxiliaries discharge their exhaust steam into the receiver of the main engine, the various auxiliary cylinders thus becoming a part of the high-pressure system of the engine, aiding to do work in its intermediate or low-pressure cylinders.

Mr. Mann here gives some valuable data and results as to the use of electric motors for operating auxiliaries, and there are many locations where the convenience of this system appeals. Each case, however, must be designed according to its own local conditions and the advantages balanced against the losses, not only of steam but of cash. It would be most interesting to study the general question of auxiliary machinery, in the power house, in the mill, and on the ship, and Mr. Mann has here given a view of one portion of this large subject, that of the operation of auxiliaries by electric motors.—The Editors.

THE exhaust steam coming from steam-driven auxiliaries is so valuable for heating feed water that the facts that such apparatus is rather inconvenient, and uses rather more steam than it ought, are condoned. In fact, it is sometimes stated that the more steam such auxiliaries use, the better, for they are really a reducing valve and all they throw away can be well used.

It is obvious that the fact that they do turn into mechanical work a portion of the heat energy in the steam consumed before passing it on to the feed-water heater, is the sole difference between such a system and that of using live steam for heating feed water. Hot feed water is an acknowledged advantage, and that feed-water-heating system is most efficient which makes good use of the largest portion of heat that cannot be used to better advantage elsewhere.

The auxiliary apparatus in an ordinary station of 10,000-kilowatts capacity provided with pumps enough to maintain a 28-inch vacuum, which pumps its own condensing water, handles its coal mechanically, and uses mechanical draft for combustion, will use about 5 per cent of the boiler output. There will be in all about twenty-nine separate

pieces of apparatus which must be driven in some way, viz.: two excitors, three circulating pumps, three air pumps, three feed pumps, two oil pumps, four fans for furnaces, two coal and ash conveyors, two coal crushers, six mechanical-stoker systems, and one or more pumps for low-pressure water service—which latter are not in use all the time, perhaps. This number will be varied slightly in different stations, but the list given is typical and the apportionment is within the bounds of sound practice.

These machines will call for 60 horse power in some cases, and 5 horse power may be taken as the lower limit. They will not all be running at one time, but under usual conditions there will be 245 useful horse power developed by such gear, and they will consume 25,500 pounds of steam per hour when valves and pistons are in good average condition. This steam will impart about 150 British thermal units to the feed water of the whole plant, giving a final temperature of 200 degrees from a cold feed of 50 degrees. The auxiliaries must be debited, then, with 25,500 pounds of steam per hour and credited with 245 useful horse power and with 2,700,000 British thermal units imparted to the feed water.

As an alternative to this system there is the possibility of using electric auxiliaries. In such a case there is no exhaust for feed-water heating. But there is something better.

The steam at about atmospheric pressure, either a little above or a little below, within a steam-turbine casing, is admirably suited for this feed-water heating. It has performed its mechanical work, and withdrawing it does not disarrange the performance of the turbine itself except in so far as a certain amount of steam does not pass through all the wheels.

To return to the actual figures already given, the 25,500 pounds of steam per hour will produce about 870 horse power in the turbine before it is reduced to atmospheric pressure. The figures would be reduced somewhat by transformation losses and the motors themselves, but not more than 20 per cent of the whole (in a certain station under consideration, slightly less than 20 per cent) and there is a balance of 690 horse power instead of 245 horse power. In other words, the feed water is just as hot, and there are 445 horse power extra developed by the main machines. The gain all comes from the fact that the turbine uses steam much more efficiently, even in the early stages, than does the ordinary steam-driven, slide-valve engine. The 245 useful horse power is needed for auxiliary driving in any case.

These figures in regard to feed-water heating are taken from a plant now in operation. The plant itself lies within fifty feet of the point where this paper is being written. It has been in operation for nearly two years, and the feed-water temperature is 216 degrees, the steam pressure within turbine casing being 2½ pounds gauge pressure. This pressure varies with the load on the turbine and with the demands for low-pressure steam for other purposes, and with it the temperature of the feed water. At times the available pressure is below the atmosphere; but the proper amount of steam goes to the heater whatever the pressure may be.

The station itself is turbine-driven, and that part of it devoted to power purposes is of 10,000-kilowatts capacity. Each turbine has its own condenser with the regular system of auxiliary apparatus.

There is, however, in the turbine casing at the point where steam is normally at about atmospheric pressure, an opening for the eduction of steam for various purposes. The pressure at this particular point varies just as does the pressure in the receiver of a compound engine, though the actual pressure is considerably less than that in the usual receiver. A branch pipe is led from this opening to a low-pressure steam main from which the closed feed-water heaters draw their supply of steam. The opening into the feed-water heater for steam is 8 inches in diameter. There is no opening for steam outlet. Whatever steam goes into the heater is condensed and passes out as water.

In any closed heater having a single opening for steam, with no steam outlet, there must be provision made for draining the low-pressure portion of the heater of condensed steam and of air. The chambers must not become water-bound, and above all must not be air-bound. If the pressure within the heater casing is always above atmosphere the drainage problem can be solved without special provision. When, however, the pressure drops to atmosphere or below, something must be done with the air as well as with the water.

In the station under discussion the lower portion of the heater shell is tapped for a 2-inch pipe and a bucket trap is placed below the heater body. The discharge of this trap is led to the condenser of the turbine. There is, besides this opening in the heater shell, a short air pipe within the body high enough above the low point so that water will not enter the orifices. This pipe is led through an air trap to the condenser. The air trap is nothing more than an ordinary expansion trap. If the vapors coming through the trap are of low temperature, the valve opens and the contents pass into the 28-inch vacuum. If the

vapors are at high temperature, it matters not whether they be air or steam, the trap closes automatically and there is no chance of escape. The bucket trap acts in a similar way when handling water. If there is water there, the valve opens and it passes straight into the condenser. When there is no water the trap closes its valve and there is no such outlet. In other words, anything that is hot and that is of value in heating feed water stays within the heater casing; if it is cold it passes over to the condenser.

The volume of vapor and water is no greater than the turbine itself can deliver, for every bit of the mass in the low-pressure portion of the heater has passed through the early stages of the turbine so that no extra work is placed upon the condensing system.

The piping connections and all joints must be tight. This is true with the condensing system, in any case, and the added joints and added attention are trivial—in fact, too small to be measured. In order to make a test of the amount of current used by the electric-driven pump for the heating of feed-water alone, electric meter readings were taken from the pump's motor when the station itself was not running and when the demand for steam was that of low pressure.

The current consumed in this case amounted to 8 kilowatts and there were at the time 75,000 pounds of water per hour being heated. This current is greater than would have been used had the turbine been in operation, because at the time a vacuum of 28 inches was being maintained in the condenser and throughout the wheel casing of one turbine without a bit of steam passing through the turbine or condenser in question, so that all stuffing boxes of valves and the like which under regular conditions, had they leaked at all, would have passed steam outward instead of leaking air inward increasing the amount of air to be handled very materially; but even were 8 kilowatts to be charged against the feed-water heating system, the results are still very much in favor of the electric-driven auxiliary apparatus as described.

There is another condition which militates favorably in such a system, and that is that all of the exhaust which enters the heater is condensed and the temperature of the water depends merely upon the surface in the heater. There is always an abundant supply of steam to draw from; that is to say, the steam is taken from a large and abundant reservoir just as it is needed. When the exhaust of the auxiliaries is the sole source of feed-water heating, if by chance the exhaust is greater in volume than the heater will condense at the time, the surplus is wasted. If, on the other hand, the supply is too small, the

feed-water heater is not efficiently used and the feed temperature drops.

It is sometimes thought that a large air pump is a very inefficient machine for handling comparatively small amounts of air, and the reason given is that the piston of the pump is drawing against the vacuum all the time and there is 14 pounds pressure on every square inch of the piston to be overcome by the motor. This idea is wrong, however. The work on the pump is nearly proportional to the amount of air handled, regardless of the size of the pump. If the amount of air is less than the pump is capable of delivering, the pressure on the atmospheric side of the piston itself is balanced, or nearly so, for a good portion of the cycle. This can be demonstrated mathematically and has been demonstrated by actual measurement on these air pumps. The maximum load on the pump occurs when the vacuum is about 18½ inches, varying with clearance. If the vacuum is less than that, the load falls off because of the decreased difference in pressure. If the vacuum is greater, the load falls off from the decrease in the mass of the air handled. The curve below is a record of a trial made on a pump to demonstrate this, and the analytic demonstration is also given. The record of the trial of the pump does not present a perfect and uniform curve because the pump valves are mechanically operated, and for the low vacuum they can be adjusted only by the sound

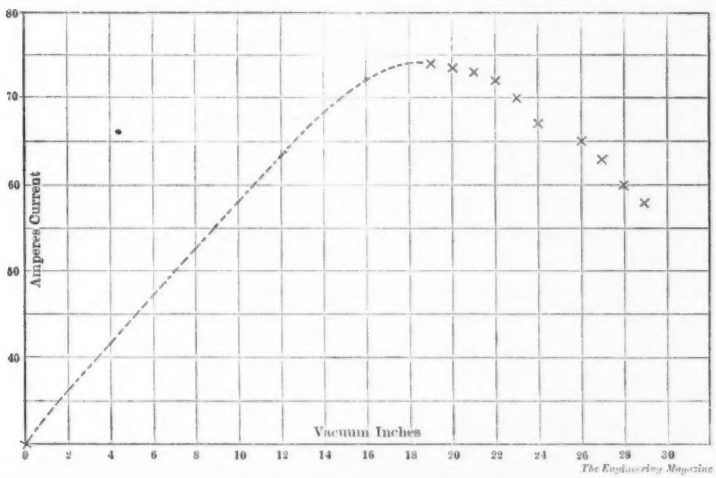
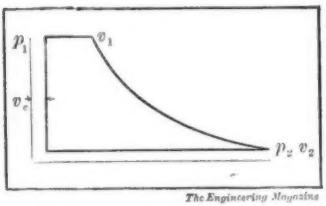


DIAGRAM OF TEST OF AIR PUMP, SHOWING POINT OF MAXIMUM LOAD.

For demonstration see following page, footnote.

which the mechanism gives out; but the curve in general is correct and demonstrates the point. The readings were taken down to 18½ inches vacuum. Below that point only one reading was to be had, i. e., that at 0 inches.

There is another great advantage in the electric auxiliary, that is to say in its convenience and its ease of operation. The twenty-nine motors here listed are cared for, including all ordinary repairs, by one man, and it takes one-half of his time; that is to say, five hours out of each of his ten are devoted to the motors. It would be difficult to conceive of twenty-nine engines of various sizes up to 60 horse power, scattered over a large building, some at the very top and extreme end and others in the basement, running properly when receiving such a limited amount of care. These motors have been running in this way for nearly two years.



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$$\text{Area} = A = p_1 v_1 + \int p\,dv - (p_1 v_c + p_2 v_2 - p_2 v_c) = p_1 v_1 + p_1 v_1 \log v_2 - p_1 v_1 \log v_1 - p_1 v_1 - p_1 v_c + \frac{p_1 v_1 v_c}{v_2}$$

$$\frac{dA}{dv_1} = 0 = p_1 + p_1 \log v_2 - p_1 (1 + \log v_1) - p_1 + \frac{p_1 v_c}{v_2}$$

$$\therefore \text{ Area is greatest when, } \log_e v_1 = \log_e v_2 - 1 + \frac{v_c}{v_2}$$

$p_1 = 14.7 \quad v_2 = 1 \quad v_c = .03 \quad \log_e v_1 = -.97 \quad v_1 = .379$

That is, the area is maximum when v_1 is .379.
The corresponding value of p_2 is 5.6 lb. or a vacuum of 18.3 ins. mercury.

NEW SHOP METHODS FROM THE MACHINIST'S POINT OF VIEW.

By W. Burns.

Questions which involve human individuality on both sides—and most questions of modern shop management are of that sort—can not find stable solution until each party has seen clearly the other's position. He may not be willing or able to occupy it himself, but he must understand what it is and what relations it has to his own stand. Mr. Burns' article is presented for the value of the hints it may give, to the employing engineer, superintendent, or manager, of the ideals and the attitude of mind of the man in the shop.

The problem of the supply of skilled mechanics for the future has weighed upon some very able and earnest employers; some side with Mr. Burns in believing that modern methods are destroying, or atrophying, the very skill in the individual upon which it must find its basic foundation. We are inclined rather to side with those who believe that there will always be those workmen who (to quote Mr. Burns) "by constantly thinking and planning when at work for quicker and better methods, have become very expert"—in other words, that there will be lack neither of material nor of opportunity for the development of the toolmaker and the highly skilled specialist on operations and processes. Collaterally, there will be developed still larger field for the employment of labor formerly wholly unskilled, in partly skilled work, immensely greater in volume and better in pay.

The process seems analogous to every preceding phase of the introduction of machinery. Eventually, it works for the advantage of all; but the time of transition is painful for many individuals, and it is a grave duty to the employer to rise to his responsibilities to lighten the burden of the worker, so far as possible. Mr. Burns' theme leads back very nearly to the text of Mr. Becker's article, in preceding pages of this number.—THE EDITORS.

IT may not be amiss, in these days of progress in machine-shop methods when our attention is directed to the performances of the high-speed steels—their advantages over the ordinary carbon steels, the particular manner in which they should be made and used to insure a maximum output— to draw attention to a phase of the subject of which comparatively little is said, namely, the view of the operative.

Until some few years ago, the machinist was allowed (to a large extent) to operate on the particular piece of work given him according to his own ideas of what was fit and proper, having tools dressed and ground as he wished and choosing his own speeds and feeds. More recently, however, and especially since the advent of the high-speed steels, conditions have greatly changed. Employers, realizing the vast saving in time possible through the use of these steels on work where much machinery was required, naturally turned their attention to the possibility of reducing the time necessary for each

separate operation. For the result, we have tool rooms where tools ready for use are stored, and given out to the machinist as required, the grinding being done by unskilled labour on a special grinding machine. Where repetition work is done, jigs and fixtures are used to reduce the time required for setting up work, and to insure that the finished pieces will be interchangeable. In addition, on certain classes of work, jigs are specially designed to be used by unskilled labour. A constant effort is directed toward the shortening of the time of the skilled machinist, his part of the work being limited to that on which skill is necessary; and a collateral effort is made to keep him constantly at the machine, and the machine always going.

In this way the cost of production is very much lessened, which is no doubt satisfactory to the employer—but what about the employee? The employer, having discovered the value of providing appliances to facilitate work, has hired highly paid specialists to plan out the lines on which the work should proceed, and to design and make suitable tools; or, to put it in another way, he has taken those workmen who, by constantly thinking and planning when at work for quicker and better methods, have become very expert, and has employed them to do the thinking for their more easy-going and perhaps less-gifted neighbours.

The average machinist working under these conditions can turn out a large quantity of work, and will continue to do so and to improve if kept constantly at it; but, should he after working in this way for some years be put to a different machine, or go to a different class of work, it will take him a considerable time to become proficient. He will find that owing to his not having to do much thinking when engaged in the routine work of the other machine, it is much harder for him to think out how to go about the work, even though at this machine he be provided with the same facilities for turning out work as at the other.

The difference is not so marked if the machinist has (as most old machinists have) a fairly general experience on two or three machines; for though this knowledge is somewhat forgotten, he still has the groundwork, and in a short time is able to produce work as quickly as others. But take the case of a young machinist brought up in a modern shop, who has been kept mostly on one class of work; should you change him on to another machine he would simply not be able to make a show of work at all, unless perhaps he has very carefully watched and studied how this machine is operated, which is generally impossible unless this particular machine should happen to be situated

near the one on which he gained experience. In some shops even this would not amount to much, as the operatives are so constantly watched over that should one be absent from his machine for five or ten minutes some official would be round looking for him. Had this young machinist been taught under the old order of things, when he would perhaps have few tools and less appliances, he would have found it necesssary to do some thinking and scheming to get his work done; consequently he would be better able to take in hand a different machine, as he would be familiar with more than one way of setting up work and using tools; the scheming he had at the other machine would assist him also in overcoming any difficulties which might arise.

Brought up under the new order of things, a young machinist would in a given time turn out better work and far more of it, as he would then be able to direct his entire attention to the actual cutting operations on the work, and these would be made easy by reason of appliances and tools suitably designed. But should you put him on a different class of work he would be at a loss till he had again become familiar with the tools and appliances. If in the course of his four or five years' apprenticeship he should get experience on three or four machines, his knowledge would be limited to that he has gained in the using of prepared machines and tools, and it will be nearly impossible for him to think out different ways of doing work and using tools. He would perhaps be able to suggest some improvement on the way in which some particular operation should be performed, but if you questioned him you would probably find that beyond the details of the operation he knew practically nothing—what the part was to be used for, why this part was finished, this part left rough, this portion to pass a limit gauge, what practical limit of error might be allowed; he would probably tell you that he did not know; his instructions were to make it that way.

Should this young man in quest of a bigger pay go to another shop —unless he happened on a shop doing exactly the same class of work and on a machine he had previously worked—he would be at a loss, and for some time would have to work at a lower rate of pay—that is, if the foreman judged he would eventually be of some use and if times were busy; but were times slack and an old hand should happen to ask for a job, the foreman would probably take the easiest way and shift the young man on the first pay day. He goes into a small job shop and wonders how it is possible for work to be turned out in a place like this, with no proper machines or tools; he will tell the men working there what machines they ought to have—but he will not be

able to work there. If he is a young fellow with grit in him he will not be discouraged by this, but will make up his mind to watch and learn all he possibly can of the different machines and methods of working, as he will soon realise that even if he has a special knowledge and can make good pay when working one particular machine, this knowledge will be of little value should he for any reason be thrown out of work.

The average older machinist, having been accustomed during his apprenticeship (when work was not so much specialized as it is now) to work on any and all sorts of work, with tools and without tools, appreciates the facilities for doing work, and is able to make full use of them; but the work not lasting long enough in one shop, he has to go to another, hence it is necessary for him to be continually observing how the work is being done by others, as he does not know how soon he may be doing the same work. By shifting from one shop to another he soon acquires a wide range of knowledge which makes him a much more valuable man both for himself and his employer. His knowledge is "cosmopolitan," is readily available, and he is able to suggest improvements seen in other shops. Working in one shop and on the same work for any length of time, and under modern conditions, he will find it very difficult to start anew in a strange shop.

Of course the older machinist has to judge for himself what he thinks will pay him best—whether to settle down in one shop or move about; but in the training of the young machinist, would it not be to the advantage of the employer and employee that the latter should, while supposed to be learning a trade, not be looked on altogether as a profit-producing unit, but rather as a young man to be instructed in the broad general principles relating to machines and the machining of metals? Where, in after years, are the men to come from who will help forward in the march of progress by improving on old machines and devising new, if the young machinists of today are trained up as specialists at one machine? A knowledge of machinery cannot be acquired save through the actual doing of work, and routine work does not tend to promote thought. The jig designer and tool maker requires to have a knowledge of machinery, to improve on existing jigs or to devise new, as his work is so intimately associated with that of the machinist, and it is fair to assume that men trained as tool makers will make but little progress without the aid of the experienced machinist.

EDITORIAL COMMENT

THE relation of the engineer to the economist is one which has occasionally been noted, and which is appearing with increasing force as time progresses. Thus an examination of the important papers of the past month, reviewed in these pages, shows that many questions of economic importance really depend upon the work of the engineer for their solution, and that statesmen are largely dependent upon the well-considered direction of the forces of Nature for the use and convenience of man for their conduct of the policies of government.

It is already well recognized that the railroad is the most effective instrument in opening up and developing new colonies, and that no scheme of colonization is of value which does not include modern transportation facilities. The railway from the Cape to Cairo is being pushed from both ends, not so much because of a demand for overland transport as because of the effect which such a bond must have in consolidating British influence throughout the length of the continent of Africa, while in like manner the lines which have been run in from the coast to the internal water communications are far more potent influences for commerce and civilization than any military or diplomatic effort could possibly have accomplished.

All the intriguing of Russia or effort of Japan was as nothing in the Far East until a line of railway communication was opened from the Urals to the Pacific coast, and the engineer had to precede the soldier and the diplomat here as elsewhere. Now the work of the same pioneer of construction must make good the waste of the men who, after a lamentable exhibition of inefficiency, even in their chosen department of work, have abandoned the field to the man who can "do for one dollar what any fool can do for two"—to the engineer, whose constructive ability is depended on to repair the waste, to develop the mineral wealth and the industrial productivity of the land which the so-called economists have been able only to impoverish.

In like manner the contentions of labor and capital are continually rendered futile by the introduction of appliances and methods which wipe from the record the very objects of discussion, and make the hard-learned lessons of experience and the subtle arguments of philosophers alike ancient history.

Much of the power of organized authority has heretofore depended upon the control of communication and the manipulation of publicity, but the engineer enables the sources of intelligence to be thrown open so that anyone who chooses may send his messages through the ether, to be picked up by anyone else who will, and communication through space succeeds communication through the official channels. Thus the engineer is the true liberator, and by his control of the great sources of power in Nature supersedes the repressive efforts of politicians—becoming the real economist, and laughing at the solemn deliberations of legislators and authorities, or watching them laboriously attempting to overtake the progress which they are alike unable to restrain or to direct.

* * *

WE have referred already in these pages to the importance of the experimental work accomplished by the United States Geological Survey in

connection with the investigations of the coal-testing plant at the St. Louis exposition. Both in the preliminary report of the committee in charge, and in the articles by Mr. Parker in this Magazine, it was made evident that the results would be of great scientific, technical, and commercial value, even within the moderate range covered during the continuance of the exposition. It has been practically decided to extend the work of this department of the Geological Survey, not only to complete the study of American fuels, but also to include an investigation of the properties of materials of construction.

In response to a resolution of the Senate, the Secretary of the Interior has recommended that the investigation of fuels and structural materials be continued, and that the sum of $350,000 be appropriated for the fiscal year commencing on July 1st, the Director of the Geological Survey having estimated that $200,000 will be necessary for the continuance of the coal-testing work, and $50,000 for the removal of the plant from the exposition grounds in St. Louis to another site. The balance of the appropriation, namely, $100,000, is recommended for the investigations of materials used in building and construction work.

This latter undertaking is practically an extension of the work already conducted by the Forestry Bureau in determining the strength of timber, and the efficiency of methods of timber preservation, and at the present time is intended to include investigation of sands, gravels, stone, cement, mortars, and similar materials most closely allied in their nature with the work of the Geological Survey.

There is precedent for the conduct of such work by the Government, and the communication of the Director of the Geological Survey to the Secretary of the Interior cites the remarkable development of the Mechanisch-Technische-Versuchs Anstalt at Berlin, and its growth into the present Königliche Materialprüfungsamt at Gross-Lichterfelde. Germany has most undoubtedly benefited by the work of this Government testing station, and there is every reason to believe that the work which has been so well done in connection with American coals may be extended to advantage to other products of Nature capable of being directed to the use and convenience of man.

* * *

An interesting feature of the proposed work of the Geological Survey in connection with the investigation of the various materials of consumption and construction is the co-operation which has been extended by many scientific and technical organizations.

The four national engineering societies are represented in the national advisory board, and other organizations are included among the bodies which have selected representatives, so that there is every reason to believe that the work of the Geological Survey will be guided in a manner which may lead to its conclusions being accepted by the men who are using the materials subjected to investigation. It is not impossible that this may prove the beginning, in the United States, of the establishment of a standard system of testing all materials of construction in such a manner as to give results comparable with the work done in other parts of the world. This would do away with much of the laborious conversion and revision now necessary.

* * *

More than two years ago, in the issue of this Magazine for February, 1904, M. Henri Dupays discussed the applicability of alcohol as a fuel for the internal-combustion motor, and showed the results of the tests in France and Germany upon stationary and automobile motors. It was there shown that the only obstacles to the development of this important industry

were those imposed by restrictive legislation; the engineer had fully demonstrated his portion of the question, and it was only the legislator who was impeding the advance of an important element in national wealth. This state of affairs is not a new one, but in justice to the politician, he appears now to be endeavoring to catch up with the progress of other members of the community, and to be really trying to do something which shall be of value to the world.

It is seldom, indeed, that the testimony before any Congressional committee is so unanimously and overwhelmingly on a single side of the question. The chief points in the plea of the advocates of tax-free alcohol for industrial use are:—

First, that it would add at once and enormously to our resources of fuel, in one of the most convenient forms for employment, either for domestic purpose or in the rapidly developing internal-combustion motor. The increase would be not only in the addition of alcohol "in being," so to speak, but in the potential increase of this industrial but non-potable alcohol from many sources now neglected and thrown to waste.

Second, as an outgrowth of this, that it would open wholly new opportunities to the farmer in the way of heavy and easily grown crops, such as the coarser sorts of potatoes, which would thus attain value as sources of crude alcohol.

Third, that it would release many industries, now using grain alcohol, from a burden of evidently needless taxation.

Fourth, that many other industries now using wood alcohol, because it is much cheaper than taxed grain alcohol, would at once reverse their practice when the removal of the tax reversed the order of cheapness; thus there would be removed at a stroke one of the curses of manufacturing operations —wood alcohol, comparable in its injurious effect on the health of operatives to the more dreaded, because more widely known, lead or mercury.

The only objection suggested—and it appeared to lie only in the minds of certain Congressmen—was a possible diminution in internal-revenue receipts. And even this is questioned by those best able to estimate the effect.

The report of the hearings before the committee on ways and means of the House of Representatives seems to show that that body is actually learning what the rest of the world has known for several years; namely, that even if there were some temporary decline in revenue, it would be a matter of immense net benefit to the community if the tax on alcohol, prohibitory now so far as fuel or industrial use is concerned, were remitted upon denaturization, under proper safeguards of Government supervision, and people were thus permitted to make something useful out of valuable material which they are now compelled to throw away. It is almost too much to hope that Congress will act with sufficient promptness to enable the United States to catch up with the countries on the other side of the Atlantic which have already removed this burden from an important industry, but at least they have begun to discover, by dint of tedious and expensive hearings, what they might have learned long ago by perusing the back numbers of the technical press of their own country as well as the papers of France and Germany.

* * *

THE recognition of Industrial Engineering as a definite field in the profession has seemed to us a necessary development of the trend of modern industrial practice. We have more than once in these pages expressed our surprise that none of the great colleges and none of the great "endowers" had heretofore realized the demand for a course which should fit the graduate

specifically for command—of course, as subaltern, to begin, but still for command—in manufacturing establishments. It has become already the destination of a large proportion of the graduates of most of the technical schools, and the proportion will increase. But while we have long had courses specialized in several departments of civil engineering—while mechanical engineering students have had opportunities to concentrate their attention upon stationary, marine, or locomotive practice—while, in fact, every branch of the long recognized divisions of the profession has been carefully sub-divided so that the student may follow the line of training which will best fit him for the labors he expects to take up—what has been offered to the man whose taste, or family tradition and interest, dictated for him the choice of a career in the management of a shop building, say, machine tools, or manufacturing soap? The nearest he could come to his needs would probably be, on the one hand, stationary steam engineering, and on the other, analytical and applied chemistry.

Something has been done, it is true, in several of the schools, in the way of giving lectures on certain features of Industrial Engineering which would at least open the students' eyes to their existence. But we are glad to see a yet more positive and definite step in this direction taken by the Clarkson Memorial School of Technology in the establishment of the course on "Economics of Manufacture" as part of the work of the junior year for the engineering students. The syllabus of Mr. Graffam's lectures seems to us to indicate a fuller concept of the scope of Industrial Engineering than has yet been shown by any other technical institute, or than has yet been embodied in any other scheme of technical instruction. It has been our conviction that the proper and necessary first step in putting this new branch of technical education on a definite foundation upon which it could build further, was the establishment of a chair in one of the recognized schools. Given such a focus, further crystallization should be rapid. The Clarkson effort in this direction, so far as our knowledge goes, is the best considered and best proportioned which has yet been made.

* * *

MR. BECKER'S discussion of "The Square Deal in Works Management", which closes in this issue, has been (we believe) a just and adequate review of the policy as it appears to its advocates and a true exhibition of the practice of many successful managers. But it must be frankly admitted that there is another side. Mr. W. S. Rogers voiced the feeling of an earnest and conscientious section of the "Opposition" at a recent meeting of the American Society of Mechanical Engineers. After telling vividly of the discouragement met by his company in getting mechanics to leave town for work amid surroundings that were already ideal, so far as the pleasures of simple, healthful life are concerned, he sums up the new movement thus :—

> "If our 'financial engineers' and captains of industry—so-called, but better termed 'pirates of industry'—had begun twenty-five years ago putting this surplus upon their employees' wages . . . the working-man to-day would be able to buy his own home in a place suitable to himself, and would have educated his children and felt himself to be a really free and independent American citizen, such as the framers of the Constitution of our country intended. Instead of that he has become a subject of paternalism, and we so-called captains of industry are trying to tell him how he must live, where he must live, how he must sleep, and a lot of other stuff that he knows as well as we do is simply bosh."

There is too much truth in this to be pleasant; nevertheless, though the idealists may be tainted with publicity-seeking and inclined to paternalism, they evidence an awakening of conscience which is hopeful of better things.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

NICKEL-VANADIUM STEELS.

PHYSICAL AND MECHANICAL PROPERTIES OF ALLOY STEELS CONTAINING VARIOUS PROPORTIONS OF NICKEL AND VANADIUM.

Leon Guillet—Revue de Métallurgie.

WE have reviewed in these columns the reports of M. Leon Guillet upon the properties of certain nickel steels, and also his researches upon vanadium alloy steels. We now have, in a recent issue of the *Revue de Métallurgie*, a study of certain alloy steels containing both nickel and vanadium, together with determinate proportions of carbon, the results of which are interesting.

In his earlier researches M. Guillet emphasised the importance of specifying the carbon content of an alloy steel, in addition to the percentage of metallic alloy, and most of his investigations have been conducted upon two groups of steels, one of moderately low carbon, 0.120 to 0.200 per cent., and the other a high-carbon steel, about 0.800 per cent.

Briefly, the properties of the nickel steels in these two groups are as follows: with a steel of 0.120 carbon there is a perlitic nickel steel, containing up to 10 per cent. of nickel; a pure martensite steel, with a nickel content from 10 to 27 per cent.; and a gamma-iron steel with a nickel content of more than 27 per cent.

With a steel of 0.800 carbon the alloy has a perlitic character up to 5 per cent. of nickel, while the martensitic structure exists when the nickel content lies between 5 and 15 per cent., and the gamma-iron alloy appears for nickel contents above 15 per cent.

The perlitic nickel steels have nearly the same properties as carbon steels, the tensile strength gradually increasing with the increase in nickel content, these steels being also more homogeneous and less brittle than carbon steels. The martensitic steels have a very high tensile strength and elastic limit, low elongation, and are brittle and extremely hard. The gamma-iron steels possess a very low elastic limit, a great elongation, and a remarkable resistance to shock.

The vanadium steels are also divided into two groups according to their carbon content, and each of these groups into three classes, according to the proportion of vanadium.

The first class of the vanadium steels is that having a perlitic structure, this appearing in steels of 0.200 carbon content with percentages of vanadium up to 0.7 per cent., while for steels of 0.800 carbon the limit of vanadium content is 0.5 per cent. When the proportion of vanadium in the 0.200 carbon steel lies between 0.7 and 3 per cent. the steel is of a perlitic structure containing a special constituent, the vanadium being in the state of a carbide; while when the percentage of vanadium exceeds 3 per cent. for the low carbon steel, and 7 per cent. for the high carbon steel the whole of the carbon is in the state of a carbide.

The properties of the vanadium steels of the three groups are summarized as follows:

So long as the vanadium exists in the state of solution in the iron the tensile strength and the elastic limit are increased, the elongation and reduction in area of

the test piece slowly diminishing, while the brittleness and hardness are very slightly increased with the increase in the percentage of vanadium. When the vanadium is in the state of carbide and there yet remains any perlite in the alloy, the tensile strength and the elastic limit diminish, and the brittleness and hardness are also reduced with the increase in the vanadium content. When all the carbon is in the state of a carbide the alloy possesses properties which vary but slightly with changes in composition. The tensile strength and the elastic limit are both low, with a fair degree of elongation, the steel being at the same time very brittle.

Having thus ascertained the properties of the nickel and the vanadium alloy steels, considered separately, M. Guillet has proceeded to investigate the influence of these elements when used jointly. For this purpose he has had prepared at the steel works at Imphy a series of such alloys, following as before the plan of studying two main groups, one having a carbon content of 0.200 per cent., and the other 0.800 per cent.

With the introduction of another element the possible combinations naturally increase in number, but M. Guillet has succeeded in weeding out those which are unsuitable for practical purposes, and then determined carefully the properties of the remaining alloys.

Taking up first the normal steels, or those which have not been subjected to any special heat treatment for the purpose of annealing or tempering, these may be divided into six classes, these including:

1. Perlitic steels,
2. Steels containing carbide and ferrite,
3. Martensitic steels,
4. Steels containing martensite and carbide,
5. Gamma iron steels,
6. Gamma iron and carbide steels.

M. Guillet gives numerous microphotographs of these alloys, and data and results of mechanical tests, and shows that a conspicuous effect of the addition of vanadium to the nickel steels is to moderate the abruptness of the changes between the several classes.

Leaving aside a number of the alloys which are of interest to the scientific investigator alone, and confining this review to the steels which have immediate uses in the constructive arts, we note first, that in the perlitic steels, those containing, for 0.200 carbon, from 2 to 12 per cent. of nickel, the tensile strength and the elastic limit are both materially increased by the addition of small percentages of vanadium. In no case should the vanadium content exceed 1 per cent., the best results being secured by the use of 0.7 to 1 per cent. of vanadium. Thus a steel containing 0.200 carbon, 2 per cent. of nickel, and 0.7 per cent. vanadium showed a tensile strength of 91,000 pounds, an elastic limit of 70,000 pounds and an elongation of 23.5 per cent. With 1 per cent. of vanadium, the ultimate tensile strength increased to 119,500 pounds, and the elastic limit to 91,000 pounds, the elongation falling to 22 per cent. A nickel steel of 0.200 per cent. carbon and 12 per cent. nickel gave, with 0.7 vanadium, a tensile strength of over 200,000 pounds per square inch, and an elastic limit of 172,000 pounds, the elongation being 6 per cent., while with 1 per cent. of vanadium the tensile strength rose to 220,000 pounds, and the limit of elasticity to 176,000 pounds, the elongation remaining unchanged. When the vanadium content is increased above 1 per cent. the tensile strength falls off, and the material begins to show evidence of brittleness.

Similar effects are produced for steels of the higher carbon, but in a lesser degree.

When the nickel-vanadium steels are subjected to a tempering process the beneficial effects of the vanadium are still further emphasised. The tempering experiments of M. Guillet were conducted by heating the steel to a temperature of 850° C., and cooling in water at 20° C. These experiments showed that a material influence was exercised upon the perlitic steels. The tensile strength and the elastic limits were increased, being nearly doubled for the low nickel content. Thus the 0.200 carbon steel with 2 per cent. of nickel, untempered, and containing 0.7 per cent. of vanadium, gave, as we have said, a tensile strength of 91,000 pounds, with an elastic limit of 70,000 pounds. The same steel, tempered from 850° C., showed a tensile strength of 168,000 pounds, and an elastic limit of 150,000 pounds, the resistance to

shock, and the hardness being also increased. This is one of the most notable features about these alloy steels, and should be given especial attention by engineers and constructors. The martensitic steels are also hardened by tempering, but the effect is not so marked with the perlitic steels.

M. Guillet's paper contains much that will interest the engineer and metallurgist, but for the constructor the principal points to be gained from his investigations are these:

The addition of vanadium is of value, so far as can be seen at present, to steels containing from 2 to 12 per cent. of nickel, and in no case should more than 1 per cent. of vanadium be used. The result is to increase both the tensile strength and the elastic limit, especially if the steel is tempered by heating to about 850° C. and cooling in water at atmospheric temperature.

These results are what might be expected from a consideration of the effects of nickel and of vanadium upon steel considered separately. An especial feature of interest is that very small additions of vanadium may be used to produce very marked effects upon nickel steels.

AN EXPERIMENTAL STUDY OF CONDENSER PROBLEMS.

THE INFLUENCE OF THE PRESENCE OF AIR IN SMALL QUANTITIES UPON THE SURFACE CONDENSATION OF LOW-PRESSURE STEAM.

James Alexander Smith—Victorian Institute of Engineers.

AT the present time, and especially in connection with steam turbine operation, the important relation between a high vacuum and good economical performance in steam engines is generally appreciated. From the days of Watt the necessity of removing the air from the condenser has been understood, the impossibility of obtaining water free from air in solution being known, but there is more than one reason for this necessity, and apart from the fact that the air itself tends to vitiate the vacuum, it has been found to exercise a peculiar influence upon the performance of condensers of the surface type. In a paper recently presented before the Victorian Institute of Engineers by Mr. James Alexander Smith, the results of some experimental investigations into the performance of surface condensers are given, and some points of practical value are brought out.

In the earlier experiences with the condensation of steam the expansion in the cylinder was carried down, perhaps to one-eighth or one-tenth of the initial, and even in multiple-expansion engines the expansion ratio rarely reached one-twentieth of the initial pressure in the high-pressure cylinder. Under such conditions the mixture of air and steam in the condenser was such that the heat was rapidly abstracted by the cold tubes of the surface condenser, and a fair vacuum was readily maintained. With the steam turbine, however, the expansion is carried to far greater ratios than was possible with the piston engine, and the exhaust is delivered to the condenser at lower pressures and temperatures than was formerly ever experienced. As a result the conditions in the condenser are altogether different. The older data as to the condensation of steam, based upon the older experiences, are therefore inadequate to serve as reliable guides, and generalisations derived from incomplete investigations of pure steam should not be assumed to be applicable to mixtures of steam and gas. The experiments of Mr. Smith have shown that such assumptions are fallacious, and that the presence of air in quantities that might have been deemed insignificant may, in fact, become the factor limiting the efficiency of a whole steam plant. For instance, air equal in pressure to only 1-20th of an inch by the mercury gauge will, at a temperature of 90° F., reduce thermal transmission some 25 per cent., while 3-20ths will lower it about one-half.

It must be remembered that air is one of the poorest conductors of heat, and that the relative proportion of air in a mixture of air and steam determines the rate of transmission of heat through the mixture. With very low pressure steam, therefore, the important effect of air in the surface condenser lies in the manner

in which, to use Mr. Smith's expression, it blankets the tubes and prevents them from doing their work to the best advantage.

The physical conditions existing in the surface condensation of steam are examined critically by Mr. Smith, and such conditions should be fully considered in the practical problem of condenser design. Given a vapor differing insensibly in temperature from that of the fluid at the same pressure, then it is at its critical point and the slightest abstraction of internal energy through the walls of the containing vessel will determine the liquefaction of a portion strictly in accordance with the energy transferred. Thus, in the case of pure saturated steam—that is, steam at its critical point—in contact with an energy absorbing, or cold surface, the most intense volume change, where the latent heat is given up or the molecular paths alter in extent from that traversed as steam to that traversed as water, is immediately at the surface. In the case of steam, given an energy sink in the form of a cooler environment, the chief limit to the rate of change is the time required for the internal energy existing as molecular motion in all directions to become in part energy of motion in one general direction of approach; in respect to the walls it is the transmitting capacity of the molecules, that is, the thermal conductivity of the solid.

Permanent gases do not even remotely approximate to their critical points at condenser temperatures. There is no selective reduction of a portion of the molecular paths, but a general, although slight, reduction of all as a consequence of cooling, and the change is accompanied by a motion of approach negligible relatively to that of the steam. It logically follows that there is a radical difference between the condensation of pure steam and that of steam mixed with a permanent gas with which it does not chemically combine.

Steam progresses continually towards the surface where it becomes water, passing away in that dense state, almost without resistance, as drops or as a gliding film. The inter-diffused gaseous molecules are impelled towards the same surface, but in that direction they cannot escape. Dalton's and Graham's laws of partial pressures and diffusion make for homogeneity of mixture, but they are rigidly true only when the volume is statically constant; here the conditions are dynamic. The result is ultimate equilibrium, but not homogeneity. Since the steam condensation is chiefly evident in laminæ of minute thickness at the condensing surface, it follows that, given a moderately rapid motion of general approach, that although the gas may at first be highly tenuous, a very slight retardation of diffusion may permit of an accumulation of molecules at that laminar surface of energy change where their impedance is a maximum.

Mr. Smith has studied these actions experimentally and visually by using glass tubes containing bromine, both with and without air in the vapor space. The low boiling point, deep non-actinic color of the vapor and strong russet-red of the condensed films, render it easy to follow the processes of diffusion and condensation, and permit the results to be photographed.

In order to determine experimentally the extent to which the theoretical conclusions obtain in practice Mr. Smith has conducted a series of careful experiments, the methods and apparatus being clearly described in his paper, to which the reader must be referred. The apparatus consists of a special form of condenser, with appliances for measuring accurately the variables, such as pressures, temperatures, rates of flow of condensing water, etc., and the results are plotted in curves.

With pure steam, free from air, and with a constant flow, the temperature increment of the cooling water showed a constant ratio to the temperature increment of the steam. Experiments with varying amounts of air, from mere traces up to 0.7 inch (mercury pressure) showed the retarding effect of successive additions of air, this effect being more marked in proportion at the lower temperatures. With a temperature of 90° F. it is shown that 0.2 inch pressure of air may almost exhaust the refrigerating power of a condenser. Mr. Smith has not yet succeeded in formulating the law governing the influence of air in condensers, but some of the conclusions deducible from his curves are instructive. Thus, with pure steam, equal increases of temperature of vapor cause equal rises of

the cooling water temperature, but this is not true when any air is present. At the higher temperatures the relative loss of efficiency by air addition is not so rapid as with lower temperatures, but the absolute loss in heat units is much greater in the former than in the latter case. The surface required is inversely as the cooling effect, therefore the difference in design between such limits as a condenser at 140° with pure steam, and one at 90° smothered with 0.3 inch pressure of air, is obvious. In this instance the effective ratio is about 7 : 1.

The injurious influence of the presence of air, as shown by the experiments of Mr. Smith calls attention to the great importance of preventing all possible air leaks. The water itself may contain about 1-30th of the feed volume, including mechanically entrained bubbles. Assuming leakage to be absent, and a minimum limit of 1-20th inch mercury pressure in the condenser, the effective volume of the air pump should be twenty times that of the feed pump. The difficulty of removing the air with very low pressures calls attention to the advantage of the subsidiary condenser, and when this is provided with a steam jet to sweep the residual gases from the main condenser, a smaller pump will suffice and will be more effective. In such a case the air pump should be differentiated from the water-removing pump. Apart from the removal of air, however, it is of vital importance that any leaks, however minute, of air into the condenser or into the pipes communicating with it, should be prevented as fatal to efficiency. When one thinks of each tube of a surface condenser as coated with an adherent film of air, one of the poorest conductors of heat known, and realizes that he has provided tubes of the best conducting material available, and is pouring cooling water through those tubes at the expenditure of much mechanical energy, he will realize the necessity of considering this element of the problem of the maintenance of the high vacua so essential to maximum steam economy.

CHICAGO DRAINAGE-CANAL IMPROVEMENTS.

CONSTRUCTION WORKS FOR THE DEVELOPMENT OF HYDRAULIC POWER FROM THE FLOW IN THE CHICAGO DRAINAGE CHANNEL.

Engineering Record.

WHEN the great drainage canal was built to reverse the current of the Chicago river, and cause the drainage of the city to be diverted from Lake Michigan to the Desplaines river, finally to be delivered into the waters of the Mississippi, it was perceived that a valuable source of hydraulic power was also possible. The plans for this work have been completed, and late in 1903 contracts for the construction works were awarded, and a portion of these works will be completed during the coming season. In a recent issue of the *Engineering Record* these important works are described in detail, and we give here a general account of the undertaking and its possibilities, while for structural details the reader may be referred to the very full account noted above.

"The works required to develop the power include the building of a head race 10,700 ft. long, with a uniform channel width of 160 ft. and a minimum depth in this channel of 22 ft., partially in excavation and partially between concrete retaining walls and earth and rock embankments; a 69x386-ft. two-story power house, built of concrete blocks, and a tail race in earth and rock excavation, which is 6,800 ft. long, 160 ft. wide and deep enough to afford a minimum depth of 22 ft. of water. This work involves, according to the contract estimates, 105,000 cu. yd. of earth excavation, 1,273,540 cu. yd. of rock excavation, 366,484 cu. yd. of earth embankment, 997,084 cu. yd. of rock embankment and more than 150,000 cu. yd. of concrete.

"The main channel of the drainage canal is 28.05 miles long and extends from the west fork of the south branch of the Chicago river, 6 miles from lake Michigan, to a controlling works at Lockport, Ill. From these works the flow is discharged into the Desplaines river, thence into the Illinois river and finally into the Mississippi river. Branches are to be built to the canal in or-

der that the sewage from large districts lying along the lake to the south and the north from the district served by the main channel may be diverted from the lake into the canal. The plans of the projects of the sanitary district for relieving the lower end of lake Michigan from sewage pollution and the construction of the portions of these plans that have been carried out have been fully described already. The main canal now carries under normal conditions a flow of 300,000 cu. ft. a minute; when the extensions already projected and the contemplated improvements to the Chicago river are carried out this flow will be practically doubled.

"The bottom of the main channel of the canal at its juction with the Chicago river is 24.448 ft. below Chicago city datum, which is the water level of 1847 in lake Michigan. The canal is built on a descending grade of 0.025 ft. to the 1,000 ft. in earth and 0.05 ft. to the 1,000 ft. in rock from this junction to the controlling works. The fall in the Desplaines river valley from datum at the controlling works to the level of a large basin, 4 1/3 miles below, which was built as a part of the improvements necessary to carry the flow of the canal and the Desplaines river through Joliet, is 42 ft. The present construction is being carried on to develop this head as fully as possible."

The controlling works at the end of the main canal involve the construction of a tail race 600 feet wide and 6,500 feet long, capable of carrying 1,500,000 cubic feet of water a minute, this having been built at the time the main canal was constructed. A head race is being constructed to connect with the main canal near the controlling works, extending downstream parallel with the tail race and to the river.

"The bottom of the main canal at the controlling works is 30.1 ft. below city datum, while the natural ground surface is only 12.4 ft. below that level. The channel is thus partially in excavation and above the natural surface it is carried by heavy concrete retaining walls backed by earth and rock embankments. The natural surface is 17.5 ft. above the bottom of the channel at the upper end of the head race, and is on a descending grade from there until at the lower end of the head race it is 3 ft. below the grade of the bottom of the latter. The bottom of the head race is level with and is continued on the grade of the bottom of the main canal. The head race has therefore also been built partially in excavation and above the top of the excavation is carried on the left-hand side, going down-stream, by a high concrete retaining wall backed by a heavy rock fill, and on the right-hand side by an earth and rock embankment.

"The concrete retaining wall and the embankment back of it are a continuation of similar construction on one side of the main canal, and in the first 2,646 ft. from the end of the latter are on tangent. The top of the inner slope of the earth and rock embankment on the right-hand side of the head race is 220 ft. from the inner face of the concrete retaining wall on the opposite side. The head race crosses a highway 1,800 ft. from the end of the canal, and in this distance it is 220 to 380 ft. wide, the earth and rock embankment having been built to conform to the topography of the natural surface. A channel, 160 ft. wide and with one edge 1.5 ft. from the inner face of the high retaining wall on the left-hand side, is excavated, however, the entire length of the head race. The natural ground surface is a loamy soil, 2.5 to 5 ft. deep, which overlies a bed rock formation of Joliet limestone that is more or less seamy and contains some clay pockets. The channel is excavated through this material. The loam over the area between the sides of the head race and outside of the channel is also stripped to the rock.

"The width of the head race is reduced to 300 ft. at the highway crossing by curving the earth and rock embankment to the left to provide for a dip in the natural surface. Just beyond this crossing the embankment is turned toward the tail race of the controlling works until the width of the head race is 580 ft. and the embankment joins an old levee along the tail race. This levee is 10 to 15 ft. high and 50 ft. wide, and was formed in making the excavation for that race. The embankment follows the levee for 3,000 ft. About 700 ft. from the turn in the embankment a 1 deg. curve to the right is introduced in the retaining wall side of the head race and is continued for 3,367 ft. The embankment on the right-

hand side being inclined slightly to the left in the same distance the width of the head race is reduced to 220 ft. just below a second highway crossing, 5,300 ft. from the upper end of the head race. From the second highway crossing to a point 9,700 ft. from the upper end of the head race the width of the latter varies from 220 to 280 ft. At that point a forebay for the power house 1,000 ft. further downstream, is commenced by inclining the right-hand side of the head race away from the opposite side until the width of the race at the power house is 660 ft."

It is estimated that these works will enable the available head of 32 feet to produce an available effect of 27,000 horse-power, when the full discharge of 600,000 cubic feet per second is delivered. The power house is to be designed to receive eight 4,000 kilowatt electric generators, direct-connected to vertical turbines, four of these, with an exciter, to be installed at first, with space for successive additions.

It is interesting to note that this power plant is a direct draft upon the hydraulic energy of the great lakes, as distinctly as are the plants at Niagara Falls, and that any attempt to protect the falls at Niagara from diminution must include every possiblye outlet of the higher lakes into any lower watershed.

GAS ENGINES FOR ELECTRIC DRIVING.

THE INFLUENCE OF SPEED CONTROL UPON THE APPLICABILITY OF GAS ENGINES FOR DRIVING ELECTRIC GENERATORS.

James Atkinson—Institution of Electrical Engineers.

GAS engines are now being used for a variety of purposes, and as the convenience and advantages of gas power are becoming appreciated their applications are certain to meet with wider and wider fields of service. One of the difficulties which has appeared in connection with the use of gas power for driving electric generators is that of accurate speed regulation. The dynamo should be run at a uniform speed, especially when employed for electric lighting, while the gas engine, especially in its earlier and simpler forms, is weak in this very matter of close speed regulation. In a paper presented recently before the Manchester section of the Institution of Electrical Engineers, by Mr. James Atkinson, this matter is considered in a very practical manner, and some of his points will be found of interest and value.

"The application of gas engines to electric driving commenced in a very small way some 25 to 28 years ago. In those days a gas engine of more than 2 or 3 horse-power was the exception, and such installations were mainly confined to lighting houses or shops. We look back to these installations with a good deal of interest, and though from our present point of view we regard them as insignificant and crude, they still did good work in their small way. They were the pioneers of what has grown to be an enormous branch of engineering, and it seems as though it were almost impossible to fix a limit to the magnitude to which gas-driven electric generation will grow in the immediate future. The great advances in the construction of a better type of dynamo very soon began to show the necessity of improving the driving capabilities of gas engines, both with respect to power and regularity.

"The improvement in the dynamo, however, frequently landed the gas-engine makers into trouble in the early days. Installations which would have passed muster with the crude old-fashioned dynamos were not satisfactory with more efficient machines; the lights driven by them would show every impulse given by the engine, and it became obvious that considerable changes were necessary in the engines, leading ultimately to the high-speed, heavily-flywheeled, special electric-lighting gas engine. The demands of electrical engineers for the required steadiness for all kinds of continuous-current driving are amply met by these single-cylinder Otto cycle, heavily-flywheeled engines both as regards steadiness of light or running a number of units in parallel. A very large number of such plants have been installed, some of them having been in satisfactory regular use for many years."

The great attraction of the gas power plant is its high fuel economy. The modern suction producer plant, using coke as fuel, and direct-coupled to an electrical generator has been shown to generate a kilowatt for 1,325 pounds of fuel per hour, the thermal efficiency of the plant being over 22 per cent., and the ratio of electrical energy to the heat energy in the fuel reaching as high as 20.8 per cent.

The principal difficulty with the gas engine, when applied to the driving of an electrical generator, appears in the fact that the piston receives a power impulse only at every other outward stroke, so that the turning moment is necessarily variable, and this gives a corresponding degree of irregularity to the motion of the dynamo, unless some very effective governing device is employed.

The original method of governing gas engines was by what is known as the hit-or-miss method, this being operated by causing the power stroke to be omitted whenever the rotative speed of the shaft exceeded that for which the centrifugal governor was regulated, and resumed as soon as the speed fell below the normal amount. Obviously such a method, although exceedingly economical as regards the consumption of gaseous fuel, did not give a uniformity of speed adapted to the driving of electric generators, and hence in the later machines other systems have been applied.

Four methods have been used for the regulation of gas engines, these being: throttle governing; cut-off governing; variation of the richness of the charge by throttling the gas; and varying the richness of the charge by changing the duration of gas admission.

The first method has the advantage of simplicity, and gives a good speed regulation, but it is wasteful of gas at low loads. The second system works very well for engines running at moderate speeds, but is not adapted to high rotative speeds, since the trip gear does not then work well.

Governing by varying the richness of the mixture, the third method above noted, has been occasionally adopted, but the narrowness of the range of speed regulation gives it a limited application.

The fourth method, that of varying the timing of the admission of gas, but always cutting it off at the end of the stroke at the same time, appears to be coming to the front.

The principle is used in both the Körting and the Oechelhauser engines, and it has the especial advantage of not decreasing the compression pressure. With the modern high compressions, reaching 150 pounds to the square inch or more the particles of air. and gas are brought closely together, and the heat due to compression is so high that the ignition temperature is nearly reached and the combustion is correspondingly complete.

"The driving of alternating-current dynamos is an altogether different problem from that of the direct current machine, excepting when they are not to be driven in parallel, in which case the conditions are the same as with continuous current dynamos. When, however, they have to be driven in parallel very much greater steadiness is required. The writer has had to do with several installations in which alternators have been driven in parallel by means of single-cylinder Otto type engines. In these cases, however, they have been flywheeled to at least double the extent of the particulars given of the previously mentioned engines, and our old friend the long belt drive has been used, the engines themselves being fitted with a very sensitive arrangement of automatic regulation which always proportioned the impulses to the load. It is of interest to know that without this automatic regulation the alternators would not run in parallel, but with it in action they have been satisfactory.

"Probably all connected with alternating machine driving will welcome the action taken by the Standardising Committee in endeavoring to limit the periodicity of alternators to either 50 or 25 cycles per second. It must be a great relief to the makers of the machines, and gas-engine makers are enabled to fix on certain revolution speeds of their engines as standards."

Mr. Atkinson examines the distribution of the turning moment upon the crank pin, and discusses the best arrangement of multiple-cylinder machines when used for driving alternators, and calls attention to the important fact that the real measure of

speed regularity is not the variation of actual rotative speed from the mean speed, but that of the angular difference of the fly wheel of the engine and that of a wheel running with an absolutely uniform rotative speed.

"One of the most remarkable features in connection with gas engines for driving electrical generators is the great increase in alternating-current machines, and such increase is still rapidly continuing. To some extent this change has been unfortunate for gas-engine makers, owing to the greater difficulties in constructing suitable engines. As, however, in most instances such engines are required to be of considerable power, more than one cylinder would be required, for this reason, as well as to give greater regularity.

"Considerable care should be exercised as to relative positions of the cranks, the flywheels, and the alternators. If it can be arranged it is desirable to build up the armature of the alternator on the flywheel itself, or at any rate directly couple it to the flywheel, without passing the strain through separate keys on the shaft. Such an arrangement works in very nicely when the cylinders can be arranged on to either one or two cranks. Should there be four cranks, as in a vertical 4-cylinder engine, it would seem desirable to use a similar arrangement, and only have one flywheel at the same end as the alternator. A considerable number of such engines have been made with a flywheel at each end, an arrangement which does not commend itself to the writer, as vibratory strains might be started up in the crankshaft itself, which under certain circumstances may be so serious as to cause fracture to the shaft. A very satisfactory method of coupling either an alternator or a continous-current machine to a gas engine is to do so by means of an elastic coupling. It is true that the cost is slightly increased, and that a larger floor space will be necessary; but this method possesses not only the great advantage of reducing the trouble of keeping so many bearings in line, but also gives a little more elasticity in the drive, and prevents risk from short-circuiting. These are advantages which more than compensate for the slight increased cost and space occupied."

ELECTRICAL MACHINERY IN MINES.

TESTS UPON THE POSSIBLE IGNITION OF MINE GASES FROM THE SPARKING OF MOTORS AND OTHER ELECTRICAL MACHINERY.

Bergassessor Beyling—Glückauf.

ELECTRIC power transmission offers so many advantages for mining operations that its use is widely extending, but it possesses one feature which demands attention and care in mines, which are subject to discharges of explosive gases; namely, the danger of ignition of firedamp and gas from the sparks and arcs which are apt to occur.

The question of the prevention of the ignition of mine gases from electric apparatus has been made the subject of exhaustive experimental investigations in Germany, and in recent issues of the German mining journal *Glückauf* there is given a review of these studies, by Bergassessor Beyling. These German investigations are by no means the first which have been made in this direction. As long ago as 1885 the subject was studied in Prussia by a special commission. In 1890 a series of investigations were undertaken by MM. Mallard, Le Chatelier, and Chesneau, for the French government, while more recently in Belgium and in England this important matter has been investigated by eminent specialists.

The present investigations were conducted in connection with the work of the Bismarck mine at Gelsenkirchen, in the Dortmund mining district, the work being conducted by a special commission, composed of Messrs. Beyling, Baum, and von Groddeck, together with representatives of the manufacturers of the various appliances tested, these being the principal electrical firms in Germany.

The appliances subjected to test included direct and alternating current motors, switches, starters, resistances, transformers, etc., the motors being operated up to 30 horse-power, under conditions approxima-

ting as nearly as possible those of actual service.

In order that the appliances should be subjected to as great dangers as exist in the worst cases in mining practice, the experiments were made in the testing gallery constructed by the Bismarck company for trials upon safety lamps and experiments with mining explosives, some modifications being made to adapt it for this special purpose.

The original gallery consisted of a timbered tunnel of elliptical section, 1.85 metres high and 1.35 metres wide, the total length being 34 metres. This tunnel is made of yellow pine staves, 60 mm. in thickness, hooped with iron rings made of I beams, and reinforced within by flat iron rings, and is provided with observation windows of heavy glass and a man hole at one end, the other end being closed by heavy masonry. In making tests upon lamps, explosives, coal dust, etc., this gallery is filled with gas drawn from a walled-up chamber in one of the deep workings of the Consolidation shaft, the gas being taken by means of a pipe and suction steam jet, and delivered to a gas holder, after having been passed through a purifier to remove the carbon dioxide. The gas consists of about 70 per cent. methane and 27 per cent. nitrogen, the balance being oxygen (corresponding to about 12 per cent. of air) and a small amount of carbon dioxide. The proportion of this gas delivered into the gallery for any test is determined by passing it through an ordinary gas meter. The gallery was prepared for the electrical tests by constructing an additional chamber at one end, into which the motors or other machines could be conveniently placed, this chamber being fitted with a special observation window.

The dangers from electric motors underground lie principally in the possibility of sparking and consequent ignition of the surrounding gaseous or dusty atmosphere. In the case of direct-current machines the the special points of danger are necessarily the brushes and commutator. In the case of alternating-current motors the danger point lies at the collecting rings and brushes. The direct-current machines have generally been considered the most dangerous so far as sparking is concerned, and no matter how carefully a machine may be constructed and adjusted sparking may be produced by sudden starting, rapidly fluctuating loads, or neglect. The alternating current motors, however, are by no means free from sparking dangers as has been generally assumed. Defective adjustment, severe vibrations, neglect to keep the collecting rings clean, these and similar causes may produce sparking quite capable of igniting the explosive mine gases. In addition to the dangers from sparking at the point of the collection of the current, there are other dangers associated with electric motors of every type. Any excessive heating in the windings may cause the burning out of insulation and the production of flame and arcs, and such accidents may occur with the best designed and most carefully built machines. Two methods, in general, have been employed by the constructors to prevent the production of explosions by motors. The first plan aims to prevent the access of gas to any parts of the motor which are liable to produce sparks, thus preventing any ignition from taking place. The second method is to enclose the motor in such a manner that any flame, due to ignited gas within the enclosure shall not be able to reach and ignite the general body of gas in the space outside.

The first plan has been carried out by enclosing the commutators, brushes, and adjacent parts in an enclosed chamber filled with oil, this acting at the same time as an insulator and as a protection against access of gas. The second plan involves the enclosing of the motor in a case, provided with openings for the circulation of air, these openings being fitted with coverings of wire gauze, so that the gas within the casing, even if it should ignite, cannot communicate its flame to the air without.

Experiments with motors of both of these types have shown that absolute safety cannot be secured by either method. The enclosed motors, while resisting various severe tests, ultimately failed by reason of the gradual entrance of the explosive gases within the case, and by the ignition of the mixture, blowing off the cover, and exposing the vicinity to danger. When the motor was enclosed in a casing in which

the openings were covered with wire gauze, any sparking caused the gas within to ignite, and the heat thus produced either caused the gauze to become red hot, or else small carbonaceous particles, adhering to the gauze, became incandescent to an extent sufficient to ignite the gases without.

Herr Beyling discusses experiments made with a view of enclosing the motors in casings which shall be altogether air-tight, thus preventing entirely the entrance of explosive gases, but this is not a simple method in view of the actual operative conditions. Each motor must have its shaft arranged to communicate with machinery without, and this implies a gas-tight stuffing box, while at the same time similar connections are usually required for adjusting levers.

A number of tests have been made upon such gas-tight casings, to determine the strength necessary to resist the force of a possible explosion within, and Herr Beyling gives the results of such tests for various air and gas mixtures. Given a chamber of sufficient strength, however, the question arises, whether it is necessary to have it made absolutely gas tight, nd according to the experiments conducted by Herr Beyling and his associates, this is not necessary. If the openings communicating with the outer air are not too large, an explosion may take place within, and the burned gases be discharged without their being able to ignite the gaseous atmosphere without, and in this fact appears the best method of arranging electric motors for use underground. Although these experiments need to be confirmed by more exhaustive researches, it appears that the best method of protecting gaseous mines from danger in the use of electric motors of any kind, is to enclose them in casings of sufficient strength to resist the force of explosion of the gas which may finds its way within, and also to provide openings for the discharge of the burned gases into the outer space. Apparently this discharge of burned gases does not act to ignite the mixture which may be without, unless the opening be too large. Experiments have shown that if the opening of the casing does not exceed 1,440 square millimetres, there is no danger of ignition to the outside gases, since the expansion of the discharging gases results in such a reduction of temperature as to make ignition impossible.

Broadly, the results of these German experiments show that electrical machinery to be used in coal mines, in which the presence of explosive gases is possible, should be constructed with the greatest care, to reduce sparking to a minimum, and that such machines should then be enclosed in casings of sufficient strength to prevent the possibility of any bursting by explosion of their contents, the casings being provided with openings of sufficient size to permit the escape of the products of explosion, and yet not large enough to allow the escape of flame. There is no doubt that further experience with the behaviour of explosive gases will enable definite data for the design of motors and other appliances for coal mines to be determined, so that close regulations may be framed, but it is only by such experimental researches as those which have been conducted in Germany that reliable information can be obtained.

HEAVY LOCOMOTIVES.

A DISCUSSION OF THE DESIGN AND OPERATION OF LARGE STEAM AND ELECTRIC LOCOMOTIVES FOR MAIN-LINE SERVICE.

J. E. Muhlfeld—New York Railroad Club.

AT a recent meeting of the New York Railroad Club there was read a paper by Mr. J. E. Muhlfeld upon the subject of large steam and electric locomotives, which is interesting for several reasons. In the first place the paper, by title and matter, was a distinct recognition by railroad men that electric traction is no longer a thing to be ignored, or treated as suitable only for street and local railways, a large concession, but one which was inevitable. In the second place the paper formed the occasion of joint discussion of traction problems by representatives of

both the railroad and the electrical construction interests, a feature which will doubtless be continued and be productive of much good.

Mr. Muhlfeld's paper deals, as its title indicates, with heavy engines, and in this lies much of its value, since it is with this department of work that the electric locomotive has, until recently, been considered of doubtful applicability. It so happens, however, that a single railroad, the Baltimore and Ohio system, is operating heavy engines of both types, and the most interesting feature of the discussion is that which gives the comparative results of these machines.

Several years ago the Baltimore and Ohio Railway introduced some heavy, direct-current locomotives for hauling trains, both passenger and freight, through the two-mile tunnel leading to its new terminal station in the city of Baltimore. These locomotives are of two kinds, the older being arranged for operation as single units and weighing about 98 tons each, while the later machines are designed in two 80-ton sections, operated on the multiple-unit system, so that, so far as dimensions are concerned, these engines are quite in the same class as heavy steam locomotives.

At the St. Louis exposition there was exhibited what was then stated to be the heaviest locomotive in the world, this being a duplex compound engine built by the American Locomotive Company for the Baltimore and Ohio Railway Company, this engine weighing 334,500 pounds, the entire weight being carried on the drivers. In his paper Mr. Muhlfeld gives data concerning the performances of the electric locomotives and this heavy steam locomotive, some abstract of which follows.

"During the past one year's service the combined mileage of two electric locomotives has been 121,015 miles, or an average of 5,042 miles per month per locomotive, computed on the basis of straight light and loaded mileage. The proportion of light and loaded mileage was half and half, about 200 miles per month per locomotive was in passenger helper service.

"Considering $1.25 per net ton as a base cost for fuel delivered at the power plant, the average total operating and maintenance expenses during the year for generating the current; the labor and material for the locomotive electrical and mechanical repairs; the engineer's wages; wiping, hostlering, inspecting, oiling and dispatching; lubricating and miscellaneous supplies, was approximately $34.50 per 100 miles run per locomotive. Of this amount the average cost of labor and material applied to each locomotive for the running and shop repairs, would be $3.20, or 52 per cent. for the electrical and $2.90, or 48 per cent. for the mechanical, making a total average cost of $6.10 per 100 miles run for both the electrical and mechanical repairs.

"The above figures do not take into consideration interest, depreciation, taxes nor insurance on the investment, nor do they include the expenses incident to the maintenance of such equipment at battery, feeders, third rail, bonding wires, insulation, safety cut-out switches, extra motors, etc., which is not required for steam locomotive operation. The wages for the conductor, or second man on the locomotive, has also been omitted.

"During their service considerable difficulty has been experienced with the shoes used for collecting the current from the surface third rail; the loosening, wear and breakage of pinions used to transmit the power from the motors to the gears on the driver wheel axles; the lubrication, heating and wear at the armature bearings; the flange and tread wear of driver wheel tire; derailments; stalling and breaking in two of freight trains due to slipping of driver wheels, more especially with wet rail or when tire of drivers connected in series are not of exact diameters, and in miscellaneous renewals and shop repairs.

"Steam locomotive No. 2400, which is of the Mallet articulated duplex compound type, was designed jointly by the builders and the railroad, and the construction was completed in April, 1904, after which it was exhibited at the Louisiana Purchase Exposition.

"After the closing of that exhibition the locomotive was brought to the Connellsville Division and put into regular service on January 6, 1905.

"For the purpose of increasing the capacity of an eastbound track, balancing of the power on the division, and to reduce the number of locomotives and crew re-

quired to handle heavy freight tonnage over a busy mountainous district, it was necessary to produce a locomotive with maximum adhesion for tractive and braking power, a minimum rail pressure per driver wheel, and a short rigid combined with a long flexible driver wheel base to adapt it to a mountain line having considerable curvature and gradient. To accomplish this it became necessary to Americanize foreign railroad practice by making use of the Mallet articulated feature, which permits of the use of a maximum effective wheel base, with a materially reduced rigid wheel base, and provides for a helper locomotive that can develop an average through freight train speed without excessive wear. The subdividing of the power through the use of four independent cylinders, pistons, main rods, crank pins and frames, in place of two, and the better balancing of the reciprocating parts, results in less strain on all parts, and reduces the liability for breakage and failure.

"While the draw bar pull behind the tender of two of the consolidation locomotives is about 79,400 pounds, the draw bar pull of the 2,400 is about 74,000 pounds when working compound, and 84,000 pounds when working simple. The weight of train that can be taken up the mountain by two of the consolidation locomotives is about 2,025 tons contained in loaded steel cars of 100,000 pounds capacity. The weight of train that the 2,400 and one of the consolidation locomotives can take up the grade is about 3,210 tons, contained in similar cars. The above figures are based on the locomotives operating at a speed of 10 miles per hour under fair coal and weather conditions, and with the 2,400 working in compound gear.

"The total elevation from Connellsville to Rockwood is 931 feet, the ruling grade between Confluence and Fort Hill being 1 per cent., and the total distance 43.4 miles.

"In through freight service, from Connellsville to Rockwood, the 2,400, singly, has moved, in 36 steel cars, 1,668 tons of lading, and 702 tons of cars, or a total of 2,370 tons in the cars. Adding the weight in working order of the locomotive and averaging the weight of the tender loaded with coal and water at 225 tons, it would make the total weight of the train, including locomotive and tender, 2,594 tons, about 64.3 per cent. of which was paying load.

"The actual running time was four hours, making an average speed of 10½ miles per hour. When handling this tonnage over the hardest pulls and around eight degrees 30 minutes curvature, as high a rate of speed was maintained as with through freight trains of 1,200 tons total, when handled by consolidation locomotives.

"Had this same train of cars been hauled by the standard consolidation type locomotive, it would have required the maximum hauling capacity of two locomotives to have handled it at the same rate of speed, and the average weight of the motive power would have been 304 tons, making the total tonnage of the train 2,674 tons, 62.4 per cent. of which would have been paying load.

"When helping trains consisting of consolidation type pulling locomotives having tractive power of 39,700 pounds, with 40 cars consisting of about 2,400 tons, weight of lading and cars, the 2,400 has pushed 36 of the 40 cars in the train on three and four degrees curvature, and 1 per cent grade, making an average speed of about 4½ miles per hour, and has pushed the entire train and pulling locomotive, weighing about 2,550 tons, when the pulling locomotive was shut off, at a speed of two miles per hour and maintained the working steam pressure and the normal water level for a distance of one-half mile on the same curvature and grade, and which performance could have been continued."

The performance of this locomotive for one year is tabulated by Mr. Muhlfeld, showing that the cost of labor and material for repairs, per 100 miles run, amounted to $3.16, or but little more than one-half that required for the electric locomotives.

"The average total operating and maintenance expenses during the year for fuel, water, labor and material for the locomotive repairs, engineer's and fireman's wages, wiping, hostlering, washing boiler, inspecting and dispatching, lubrication and miscellaneous supplies, was approximately $24.50 per 100 miles run. To this figure can be added an allowance on account of general repairs and renewals to locomotive, mileage credited but not actually run, difference in cost of fuel delivered at power plant and on locomotive tender, and for the main-

tenance of fuel and water supply plants, and there will still be a large margin in favor of the steam as compared with electric locomotive performance, under fairly similar conditions."

Mr. Muhlfeld draws the conclusion, from these comparative results, that, except under conditions where the use of steam locomotives is prohibited, the greater cost of operating electric locomotives must prevent their use for heavy railroad work. Under present conditions, this is doubtless correct, and any comparison based wholly upon operative costs, leaving out of consideration of the other advantages of electrical operation, would doubtless lead to the same conclusion. The situation is somewhat like that which appeared when electric driving was first proposed for machine tools.

It was found tha there was no material economy in power, and in many cases a positive loss, and yet the electric motor is steadily making its way in the shop to drive machine tools because of its many advantages over and above the actual cost of power. No doubt the efficiency of the electric locomotive will be greatly improved, but it must be remembered that there are other things besides the cost of fuel and repairs which enter into transportation problems, and that the successful system is the one which takes into account "all the conditions there are."

THE MANUFACTURE OF ARTIFICIAL NITRATES.

PROCESSES FOR THE FIXATION OF ATMOSPHERIC NITROGEN, AND ITS APPLICATION TO THE MANUFACTURE OF ARTIFICIAL FERTILIZERS.

Zeitschrift für Angewandte Chemie—Engineering.

FOR a number of years the chemist and technologist have been endeavoring to devise some method for utilizing the nitrogen of the atmosphere by converting it into a nitrate available for fertilizing the soil of wheat-growing districts. More than five years ago, in his presidential address before the British Association for the Advancement of Science, Sir William Crookes called attention to the necessity for providing some inexpensive form of combined nitrogen, suitable to replace the demands made upon the soil of our wheat growing areas.

At the present time the nitrogen fertilizer used is "Chili saltpetre," a nitrate of sodium, existing in natural deposits on the slope of the Andes, and mined and exported from Chili at the rate of more than a million tons a year. The total extent of the deposits is not positively known. According to some estimates the supply will be practically exhausted in about twenty years, others believe that the beds may last until about 1950. In any case the price must rapidly rise as the supply diminishes, and this is certain to occur unless some new source is provided. The whole question has been discussed at length by Dr. Albert Neuburger in the *Zeitschrift für Angewandte Chemie,* and has also been made the subject of a special article in a recent issue of *Engineering,* and as the principal point involved, the fixation of atmospheric nitrogen is really an electrical problem, and the vital question of cost depends largely upon the provision of cheap sources of motive power, the problem is one which comes well within the province of the engineer.

Dr. Neuberger classifies the methods of utilizing atmospheric nitrogen into four groups: the direct production of nitrates; the production of ammonia and ammoniacal salts; the production of cyanides and their derivatives, and the direct fixation of nitrogen and oxygen into nitric oxide, and thence to nitrous and nitric acids. At the present time the greatest interest is found in the last of these four methods, that of fixing the nitrogen by inducing it to form a chemical combination with the oxygen of the air, with which it is ordinarily associated only as a mechanical mixture. The fact that electric sparks caused a portion of the atmospheric nitrogen to become oxidized was observed by Cavendish in 1781 and by Priestley in 1786. The subject was taken up again in the laboratory by Bunsen, in 1857, but it was only when the modern dynamo, and especially the modern hydro-electric station showed

the way to the production of large quantities of electricity on a commercial scale that the question could be seriously considered as a process of manufacture. During the past few years the subject has been attacked in various ways, and while it is not certain that commercial success has been attained the results are encouraging.

When electric sparks or silent discharges of high-tension currents are passed through air, the oxygen is ozonized and the nitrogen oxidized to various compounds, the principal one being nitric oxide; nitric dioxide being also produced subsequently by combination with the oxygen of the atmosphere.

"The technical electrothermic nitric acid process may be said to consist of several stages: the oxidation of the nitrogen by the spark or flame, which is effected in a kind of furnace; the reaction between the nitric oxide with oxygen to form nitric dioxide, effected in reaction chambers; the absorption of the oxides by water or some caustic lye to form nitrates and nitrites or the free acids.

"The oxidation of the nitrogen requires a high temperature, which can be produced by electrical or by other means. The most suitable temperatures of the small arcs and flames used for these reactions have been estimated from 1,600 degrees to 3,000 degrees C. They depend upon the length of the arcs and other conditions. All the estimates are uncertain, moreover; and Nernst has pointed out why this must be so. We determine the composition of the resulting gas mixture after it has cooled down; but since the cooling cannot be effected instantaneously, too little will, as a rule, be found of the compound which was formed at the highest temperature. Nernst hismelf experimented with his glow-lamps and with his tubular platinum and iridium furnaces; the air was simply heated and not exposed to electric discharges. The resulting nitric oxide is redecomposed if kept too long in the flame, and has hence to be quickly removed. The investigator has therefore to determine at what temperature and what rate of airfeed an equilibrium can be maintained insuring the maximum yield of nitric oxide."

The first attempt to produce nitrogen compounds in this manner on a commercial scale was that of Bradley and Lovejoy, at Niagara Falls, but this has not yet proved a commercial success.

At the present time interest is given to the process of Birkeland and Eyde, in Sweden, this being based upon the use of flame electrodes of the magnetic blow-pipe type.

"A powerful magnetic field flattens out an arc discharge; with alternating currents a complete flame disk results, with direct currents a half disk. What really happens is, that each little arc is deflected and caused to travel away from the electrodes, until it breaks off; a new arc is at once formed, and thus the disk consists of a series of little arcs in motion which are automatically extinguished. With alternating currents the arcs travel alternately to the right and left, thus producing a flame disk.

"The first communication on the process was made by S. Edstrom at St. Louis in 1904. The experimental furnace then in use worked at Ankerlökken, near Christiania, with arcs consuming up to 200 kilowatts per pair of electrodes, fed with alternating currents of 5,000 volts and 50 cycles. The three furnaces now in operation at Notodden absorb 500 kilowatts each. The furnaces form cylindrical boxes, standing on their edge, or, rather, suspended between two vertical uprights, to the ends of which the coils of the electromagnets are attached. The poles lie in the horizontal axis of the cylinder, and the two perpendicular arc electrodes are at right angles to them. The flame disk of each furnace has a diameter of more than 2 meters. The air enters through ports on both sides of the disk, and is drawn off below, having passed right through the plane of the flame.

"The electrodes are hollow copper rods, rounded off and closed at the ends; water circulates in them, and as the striking points of the arc are constantly being shifted by the magnetic deflection, the wear of the electrodes is inconsiderable. Electrodes have, in fact, been kept in uninterrupted use for hundreds of hours.

"The air leaving the furnace contains not more than 2 per cent. of nitric oxide, and passes first into the reaction or oxidation chambers, in which the gas current is checked in order to cool and to oxidize the

nitric oxide to nitric dioxide. That these reaction chambers must have ample dimensions, and that sufficient time must be allowed, is clear from Lepel's researches. The gas is then conducted to eight absorption towers, built up of granite and charged with quartz, in which the gas meets water. The dilute acid flowing off below is again raised, and made to trickle down once more, until the contents of nitric acid have risen to 50 per cent. Two more towers, irrigated with milk of lime, and further, a dry lime chamber, are added to absorb the last traces of acid. The obtained nitric acid is neutralized with limestone, and the calcium nitrate is evaporated and fused with the waste heat of the reaction chambers, and run into iron cases. Among the improvements now under trial is one according to which the nitric dioxide gas is directly passed through the evaporation pans. Any perfection permitting of a more direct method of binding the very dilute gas mixture would, of course, be of the greatest importance, and the technical problems concern the chemist and engineer more than the electrician.

"The average yield is now, at Notodden, from 500 to 600 kilogrammes of nitric acid per kilowatt-year. This statement by the firm is fully borne out by independent tests carried out by several methods, which Prof. Witt conducted on various occasions, and which repeatedly yielded a considerably higher efficiency. There is abundance of available water power. The Tinfos, near by, which is now utilized, can spare 20,000 horse-power; the Svälfos, three miles off, could give 30,000 horse-power; the Rjukanfos, further off, 300,000 horse-power; and it is calculated that the horse-power could be obtained at the exceptionally low rate of 12s. per year. Under these circumstances the good calcium nitrate produced at Notodden could certainly compete with the Chili saltpeter.

LOCOMOTIVE TESTING AT ST. LOUIS.

RESULTS OF TESTS MADE ON THE LOCOMOTIVE TESTING PLANT OF THE PENNSYLVANIA RAILROAD SYSTEM AT THE ST. LOUIS EXHIBITION.

Report of the Testing Staff and Advisory Committee.

AT the international exhibition at St. Louis one of the objects of especial interest to the railroad engineer was the locomotive testing plant installed by the Pennsylvania Railroad Company, this being practically a reproduction, with improvements and additions, of the testing plant arranged by Professor Goss several years before at Purdue University. A preliminary report of some of the work of this testing plant has already been issued, and now we have a portly volume, published under the auspices of the Pennsylvania Railroad System, giving a complete description of the whole equipment, and detailed reports of the tests upon eight locomotives, representing the latest types of simple and compound freight and passenger locomotives.

The general arrangement of the locomotive testing plant has already been described in the technical press, and an illustration of the exhibit at the St. Louis exhibition was given in our issue for October, 1904. Briefly, the method consists in placing the locomotive to be tested upon a set of wheels, arranged beneath the drivers in such a manner that the revolutions of the wheels of the locomotive cause the supporting wheels to revolve at the same rate as would be the forward movement of the engine upon the track, the resistance being supplied by dynamometer brakes upon the axes of the supporting wheels. The pull upon the draw bar is measured by a spring dynamometer, while the various operative data, such as indicator diagrams, steam, furnace, and smoke-box temperatures, etc., are readily obtainable, since the engine is stationary, although operating at rates corresponding to full operative speeds upon the road.

During the exhibition eight locomotives were tested, these including American, French and German engines, both simple and compound, for freight and passenger service. These tests were made to show the performance of both engines and boilers, both at average and maximum conditions, and some very interesting results were obtained.

Perhaps no better indication of the results of the tests can be given than by publishing the summary of conclusions accompanying the report, including the performances of both boilers and engines.

"Contrary to a common assumption the results show that when forced to maximum power, the large boilers delivered as much steam per unit area of heating surface as the small ones. At maximum power, a majority of the boilers tested, delivered 12 lbs. (or more) of steam per sq. ft. of heating surface per hour; two delivered more than 14 lb., and one, the second in point of size, delivered 16.3 lb. These values expressed in terms of boiler HP. per sq. ft. of heating surface are 0.34, 0.40 and 0.47, respectively.

The two boilers holding the first and second place with respect to weight of steam delivered per sq. ft. of heating surface are those of passenger locomotives. The quality of steam delivered by the boilers of locomotives under constant conditions of operation is high, varying somewhat with different locomotives and with changes in the amount of power developed, between the limits of 98.3 per cent. and 99.0 per cent.

The evaporative efficiency is generally maximum when the power delivered is least. Under conditions of maximum efficiency, most of the boilers tested evaporated between 10 and 12 lb. of water per lb. of dry coal. The efficiency falls as the rate of evaporation increases. When the power developed is greatest, its value commonly lies between limits of 6 and 8 lb. of water per lb. of dry coal.

The observed temperature of the fire-box under low rates of combustion lies between the limits of 1,400° F. and 2,000° F., depending apparently upon characteristics of the locomotive. As the rate of combustion is increased, the temperature slowly increases, maximum values generally lying between the limits of 2,100° and 2,300° F. The smokebox temperature for all boilers, when worked at light power, is not far from 500° F. As the power is increased, the temperature rises, the maximum value depending upon the extent to which the boiler is forced. For the locomotives tested, it lies in most cases between 600 and 700°.

With reference to grate area, the results prove beyond question that the furnace losses due to excess air are not increased by increasing the area. In general, it appears that the boilers for which the ratio of grate surface to heating surface is largest are those of greatest capacity. A brick arch in the fire-box results in some increase in furnace temperature and improves the combustion of the gases. The loss of heat through imperfect combustion is in most cases small, except as represented by the discharge from the stack of solid particles of fuel. Relatively large firebox heating surface appears to give no advantage either with reference to capacity or efficiency. The fact seems to be that the tube heating surface is capable of absorbing such heat as may not be taken up by the firebox.

The indicated horse-power of the modern somple freight locomotive tested may be as great as 1,000 or 1,100; that of a modern compound passenger locomotive may exceed 1,600 horse power. The maximum indicated horse power per square foot of grate surface lies, for the freight locomotives, between the limits of 31.2 and 21.1 horse power for the passenger locomotives, between 33.5 and 28.1 horse power.

The steam consumption per indicated horse power necessarily depends upon the conditions of speed and cut-off. For the simple freight locomotives tested the average minimum is 23.7. The consumption when developing maximum power is 23.8 and when under those conditions which proved to be the least efficient, 29.0. The compound locomotives tested, using saturated steam, consumed from 18.6 to 27 pounds of steam per indicated horse power hour. Aided by a superheater, the minimum consumption is reduced to 16.6 pounds of superheated steam per hour.

In general the steam consumption of simple locomotives decreases with increase of speed, while that of the compound locomotives increase. From this statement it appears that the relative advantages to be derived from the use of the compound diminish as the speed is increased.

The percentage of the cylinder power which appears as a stress in the drawbar, diminishes with increase of speed. At 40 revolutions per minute, the maximum is 94 and the minimum 77; at 280 revolutions per minute, the maximum is 87 and the minimum 62.

The loss of power between the cylinder and drawbar is generally affected by the character of the lubricant. It appears from the tests that the substitution of grease for oil upon axles and crank pins increases the machine friction from 75 to 100 per cent.

The coal consumption per dynamometer horse power-hour for the simple freight locomotives tested, is at low speeds not less than 3.5 pounds nor more than 4.5 pounds, the value varying with runing conditions. At the highest speeds covered by the tests, the coal consumption for the simple locomotives increased to more than 5 pounds. The coal consumption per dynamometer horse power-hour for the compound freight locomotives tested is, for low speeds, between 2.0 and 3.7 pounds. Results at higher speeds were obtained only from a two-cylinder compound, the efficiency of which under all conditions is shown to be very high. The coal consumption per dynamometer horse- power-hour for this locomotive at the higher speeds increases from 3.2 to 3.6 pounds. The coal consumption per dynamometer horse power-hour, for the four compound pasenger locomotives tested, varies from 2.2 to more than 5 pounds per hour, depending upon the running conditions. In the case of all of these locomotives, the consumption increases rapidly as the speed is increased.

A comparison of the performance of the compound freight locomotives with that of the simple freight locomotives is very favorable to the compounds. For a given amount of power at the drawbar, the poorest compound shows a saving in coal over the best simple which will average above 10 per cent., while the best compound shows a saving over the poorest simple which is not far from 40 per cent. It should be remembered, however, that the conditions of the tests, which provide for the continuous operation of the locomotives at constant speed and load throughout the period covered by the observations, are all favorable to the compound.

It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse-power at the drawbar upon the consumption of but a trifle more than 2 lbs. of coal per hour. This fact gives the locomotive high rank as a steam power plant. It is worthy of mention that the coal consumption per horse power hour developed at the drawbar by the different locomotives tested presents marked differences. Some of these are easily explained from a consideration of the characteristics of the locomotives involved. Where the data are not sufficient to permit the assignment of a definite cause, there can be no doubt but that an extension of the study already made will serve to reveal it."

ELECTRIC DRIVING OF MACHINE TOOLS.

A STUDY OF THE RELATION OF ELECTRIC DRIVING TO THE GENERAL ECONOMY OF MACHINE-SHOP OPERATION.

E. R. Douglas—Electrical Review.

ENGINEERS and works managers are beginning to realize that there is little use in considering operative advantages and economies in detail unless these can be shown also to have a favorable effect upon the performance of the entire plant. This is no new idea, but apparently it has to be learned over and over again. It is not necessary that an engine should show an economy in steam provided it can show a saving in money, and there is little use in putting in a high priced machine tool, of certified high efficiency, unless the conditions are such that it can be maintained in operation continuously. It is an old saying that valuable horses kept in the stable are very successful in "eating their heads off," and this performance is not limited to horses, but may be applied to some mechanical installations as well. At the same time it is found that appliances which may not be economical in the sense that their advocates desire to impress may be found advantageous in other respects, and among such subjects may be included the electric motor, when set at the uncertain task of driving machine tools. In an article in a recent issue of the *Electrical Review* there is an instructive paper by Mr. E. R. Douglas upon

the economy of electric driving in the machine shop, from which we make some abstracts.

"A few years ago the question of motor driving was considered entirely on the basis of saving in power. Much ingenuity was spent in computing power losses in line shafting, belts and countershafts and in determining the precise points where saving in power was offset by increased investment charges. It is undeniable that the loss in transmitting power electrically, except over short distances, is less than with mechanical transmission, especially as the amounts of power become large; and, when the driven units are few and large, the first cost of motors and wiring may be no greater than the cost of shafting and hangers. The motor-drive problem then becomes comparatively simple.

"But with greater subdivision and smaller absorbing units the first cost is increased enormously. Not only are small motors relatively more expensive than large ones, but the number of motors standing idle or running lightly loaded at any time is greater. The total motor capacity for the plant is therefore much increased, even three, four, or five times. For these reasons applications of motors to the driving of factories were at first confined to the class known as 'group driving, in which a few good-sized motors drive independent short lengths of line shafting to each of which a group of machines is connected by means of belts and countershafts.

"When electric motors began to be used in machine shop driving it was soon found that there were other advantages besides those of power economy to be considered. The removal of belts gave better lighting and greater flexibility in the arrangement of tools, the line-shaft being no longer the main criterion in the placing of machines. By placing tools in the natural order of the progress of the work, and by utilizing the space to the best advantage it was found that dollars in time might be saved even when there was no appreciable gain in power cost. There is always an advantage in being able to cut off the use of power when a machine is thrown out of operation, but in any case it should be remembered that the cost of power is only about two per cent. of the total cost of manufacture, while labor reaches from thirty to fifty per cent., so that anything which enables the work of the mechanic to be utilized to better advantage should be given first consideration.

"It will be seen that the argument for motor driving has tended, from its first position where cost of power was alone considered, toward one in which comfort, convenience and general economy are more important. There is a dollars and cents argument for this. Men work better and do more when they are comfortable, when light and ventilation are good. Convenience means minimizing of delay and more rapid production. There is often a greater saving from the entire elimination of small losses than from trifling reductions on the larger items of expense.

"But with all these advantages motor driving of factories proceeded for a number of years at only a moderate pace. The electrical companies worked for what they got and were often met with apathy or even determined opposition. It required a combination of two great improvements, directly affecting production, to bring about a change. These were the introduction of high-speed steel for cutting tools and the development of commercially practical variable-speed motors. With these came an appreciation of the importance of the labor element in manufacturing operations and certain carefully worked out systems for determining that and other elements of cost."

With the introduction of electrical driving of machine tools came also the high-speed tool steels, and these steels need above everything else a proper control over the cutting speeds on the work. An increase of the linear speed of the work before the point of the tool from two to four times that which had hitherto been possible, came into the shop about the same time that the electric motor appeared on the field, and naturally both elements demanded consideration together.

"In the upheaval caused by these steels much that was obsolete beside cutting speeds was brought to light. When it was attempted to use such steels at their highest speeds on machine tools of ordinary designs, those tools speedily developed structural weaknesses, made apparent by

breaking down or by excessive vibration. The general line of metal-working machinery has had to be largely redesigned, not only made heavier, but changed entirely in important details in order that the machinist may avail himself of the highest speeds now possible.

"It would also seem that even the steels formerly standard were not, except in a very few cases, used up to their limit of capacity, this owing to lack of knowledge on the part of the workman as to what he could do, lack of attention on the part of the foreman, if he had the knowledge, and general indifference to the details of rapid production. The advent of the new steels called attention to this laxness and to the need of taking complete advantage of the new situation. If a tool steel, which, under given conditions could cut at 100 feet a minute, were actually used at only eighty feet, the time of machining would thereby be increased twenty-five per cent., a margin well worth saving."

With the old belt driven tools the number of speed changes was necessarily limited, and often a mistake was made in endeavoring to use a speed too high, because the next lower speed was lower than was really desired.

At first the electric motor failed also to meet the requirements of speed changes, but this problem has been attacked by a number of designers, and now a variety of speed-changing systems are in the field.

"The commercially successful system of motor-speed control may be grouped under three classes: two-wire system, three-wire systems and four-wire systems.

"The two-wire systems make use of a single voltage and a motor capable of large speed variations by field regulation. Until recently it was not found practical to make a variation in speed of more than thirty per cent. in this manner, as the tendency of the motor to spark became excessive at the higher speeds and weak fields. Improvements in motors now permit of speed ranges of 2 : 1 or 3 : 1, and in the case of certain very special motors as much as 6 : 1, with fairly satisfactory results. The sizes of motors required for these large ranges become, however, very great as compared with the size of constant-speed motors of the same output, or even as compared with variable-speed motors on the three or four-wire systems. The two-wire system is one, nevertheless, of great promise for situations where the others are not deemed advisable.

"The most common three-wire system makes use of 230 volts between mains and 115 volts between each main and neutral. This gives two speeds directly on the voltages. The increase by field regulation necessary to bridge the gap between them is nearly 100 per cent. and the same increase is usually made above the 230-volt speed as well. The total range then becomes 4 : 1. The three-wire system is also used with uneven voltages, as, for instance, seventy-seven and 153, respectively, between the neutral and the outside wires, the main voltage being 230. Then 100 per cent. increase by field regulation is necessary above seventy-seven volts and fifty per cent. above 153 volts. If 100 per cent. can be used above 230 volts, a 6 : 1 range is obtained. With fifty per cent. above 230 volts the range becomes 4.5 : 1.

Mr. Douglas gives a number of examples of the speed changes obtainable in lathe work by a combination of motor changes and change-gears, with charts showing the power consumed for work of various diameters. A practical example of turning on a forged shaft with plate coupling is given, with the times required for carrying out the work under ideal and under practical conditions. It is shown that, under average conditions, the practical gain due to better control of speeds, a saving of more than 35 per cent. in the labor cost would result from the use of the electric motor over belt driving.

There is little doubt that electric driving possesses many advantages, but the manager who attempts to make a decision solely upon the point of power saving is very apt to be deceived. The question should be considered upon its merits, taking into account the operative conditions actually existing in the shop under consideration, remembering always that the great point is to keep down the labor-cost of the product, and that, not by reducing the rate per man, but by increasing the output, so as to diminish the relative expense burden as well as the direct labor-cost.

AUTOMOBILE-VEHICLE DEVELOPMENT.

THE INFLUENCE OF THE DEVELOPMENT OF THE MECHANICALLY-PROPELLED VEHICLE UPON SOCIAL AND COMMERCIAL INTERESTS.

Claude Johnson—Journal of the Society of Arts.

WE have had numerous papers devoted to the description of various types of automobile vehicles, and others discussing structural details, fuels, manufacturing methods and the like, all of which are interesting and appropriate in the course of the development of a great industry. The broad subject of the growth of the mechanically-propelled vehicle, its influence as a substitute for animal traction, its relation to the commercial and personal life of the community—these are also questions which demand the attention of the engineer; and these and related subjects form the substance of an address recently delivered by Mr. Claude Johnson before the Society of Arts, and published in the *Journal* of the society.

After a brief reference to the extent to which antiquated legislation prevented the early development of mechanical vehicles in Great Britain, Mr. Johnson gives an historical resume of the growth of the automobile industry, from the fundamental work of Daimler in Germany to the later efforts of the French constructors, and then takes up the detailed development year by year from 1895, and the enactment of legislation permitting the use of motor vehicles on roads in the United Kingdom.

From this point the history of automobile development is mainly one of mechanics and engineering. France, having had no legal restrictions to impede the work, naturally gained a good lead, and with the opening of the Automobile Club de France in 1896, following the Paris-Bordeaux race, and the exposition at the Palais d'Industrie of the preceding year, the automobile interest really began in earnest.

At first the interest centred in speed trials, and the Paris-Marseilles race of 1896, over a distance of 1,076 miles was the beginning of a series of trials which undoubtedly did much to develop the motor car. This was followed by numerous exhibitions, races and competitions, which Mr. Johnson describes with some detail, extending down to the close of 1905. It is interesting to note that in the original Paris-Marseilles race of 1895 the average speed of the winner was 15.6 miles, while in the Vanderbilt cup race in America in 1905 there was covered a distance of 198 miles at an average speed of 69.9 miles per hour.

Mr. Johnson has prepared for publication a chart showing the distance over which the famous motor races were run, and the average speed attained by the wining cars. This chart shows the average speed in 1894 as 12 miles an hour, and the average speed in 1903 as 62.5 miles per hour.

"The subject of motor racing cannot be left without refering to the undoubted benefit which long distance racing was to the motor industry. The keen contests which took place between maker and maker and between nation and nation, have resulted in its being discovered by constructors that cars can, by the use of the very best material, be constructed within weight limits, which would not have been admitted as theoretically possible by consulting engineers ten years ago. Since 1901, however, there has been a feeling that the time would come when the racing of purely racing machines would cease to be of particular advantage in the design and construction of touring cars. The Automobile Club of Great Britain therefore started last year a new form of racing for what is called the Tourist Trophy, in which the cars have to me *bonâ-fide* touring cars, affording a certain amount of seating capacity, and carrying four passengers or their equivalent weight on *chassis* of not less than a certain weight. The speed of the cars is limited by the fuel allowance, the same quantity of fuel being given to all the competing cars. The car which completes the distance in the shortest time, that is, the car which can most efficiently transmit the power obtained from the motor to the road wheels, and can cover the distance without running out of petrol and without delay, is the car which wins. It is thought by many experts that this new form of racing is likely to con-

siderably improve the construction and design of touring cars, inasmuch as it compels makers to study the question of efficiency rather than to obtain speed out of their cars by means of engines which are unnecessarily large in order to overcome the inefficiency of transmission."

In most of the development of the high-speed motor car the honors went to Continental builders, but with the formation of the Liverpool Self-Propelled Traffic Association came the excellent work done by that body in promoting the construction of vehicles for heavy traffic. The efforts of such men as Professor Hele-Shaw, Mr. E. Shrapnell Smith, Sir Boverton Redwood, and others, have resulted in the development of an industry of importance which is destined to work a revolution in the design of heavy mechanically propelled vehicles.

Mr. Johnson reviews successive the subjects of legislation, automobile associations, technical and trade publications devoted to automobilism, and the position which automobilism has taken in the social and industrial worlds, and concludes with a resume of the growth of the industry as a whole.

"Six years ago the writer spent many hours in watching on the big highways leading out of London for passing motor-cars without seeing one, and if he did see one, he could at once recognise the owner and make of the car. Now one can scarcely cross the road without having to run to avoid a motor-car, and the makes of cars are so numerous that it is difficult to identify them.

"Twelve years ago the average speed of a racing car over a long distance was 12 miles an hour. To-day, the average long distance speed is 69 miles an hour. Eight years ago there were 163 members of the Automobile Club. Now there are 2,860.

"Seven years ago one was regarded as insane if one drove a motor. Now one is regarded as insane if one does not drive one.

"Two years ago a motor-omnibus was regarded as a curiosity. To-day there are 260 running in London. Seven years ago there were only a few people who drove motors. Now there are so many drivers of motors that the receipts of the railway companies have been seriously affected.

"Seven years ago, at the Richmond Show, there was only one 4-cylinder motor, now nearly all motor cars, except the lighter and cheaper classes are fitted with 4-cylinder motors, except those with the 6-cylinder motor, which were first introduced by Messrs. Napier and Edge three years ago, and those fitted with 8-cylinders. The 6-cylinder motor is without doubt gaining ground, seeing that one crank-shaft maker alone in this country is making 6-cylinder crank shafts for 13 firms. Mr. Edge's 6-cylinder car held the world's record for speed last year. The 8-cylinder motor V type, which is built by Levassor and was used in motor-boats last year, has been adopted by the company in which the writer is commercially interested, in motor-cars, the first cars fitted with one being shown at the last exhibition at Olympia, and the 8-cylinder "V" motor has since then been adopted by the Darracq Company on their racing car, with which they have attained the speed of 122½ miles an hour. Seven years ago, although Benz, Mors, and others were using and had always used electric ignition, Panhard and Daimler were still using tube ignition, and the only magneto shown was that fitted to Mr. Simms' motor cycle. To-day tube ignition has been abandoned, and the magneto is rapidly taking the place of electric ignition.

"Ten years ago the *Daily Telegraph* thought that we were not within measurable distance of the day on which the people in society would use electric carriages for town work. Six years after this wise announcement most of the leaders of London society were using electric carriages, and to-day there are said to be 500 electric carriages in use. Seven years ago at the Richmond exhibition there were 130 motor-cars and commercial vehicles, and 16 motor-cycles exhibited. Last November at Olympia, there were 496 vehicles shown, of which 56 per cent. were British vehicles, 93 per cent. were petrol, 4 per cent. steam, and 3 per cent. electricity. Seven years ago a motor exhibition involved a loss of £1,600; now a motor exhibition means a profit of many thousand pounds.

"Seven years ago the annual output of cars of the motor companies in this country could be counted in scores. This year the Daimler Company—which last year made a profit of £80,000—hopes to turn out over

1,000 *chassis;* the Argyle Company hopes to manufatcure 1,500 complete cars this year; the Napier Company claim to be turning out *chassis* having a selling value of half-a-million pounds per annum; and the Wolseley Company employ 2,000 men, and have a wages-bill of more than £150,000 per annum. Probably the salaries and wages paid in this kingdom in the motor industry amount to £1,500,000 per annum, and the turnover to £5.500,000."

These figures relate solely to the development of the automobile industry in Great Britain, and show the extent of the new industries and new sources of wealth which the work of the engineer has created in a single line of work, not by diverting capital and labour from other departments of industry, but by giving new occupation to men and money. If, to this notable showing, there is added the still greater development of the same industry on the Continent and in the United States it will be seen to how great a degree mechanical invention and engineering enterprise may add to national wealth.

LOCOMOTIVE BOILERS.

NOTES ON THE DESIGN AND OPERATION OF LOCOMOTIVE BOILERS, WITH ESPECIAL REFERENCE TO THE INCREASE IN SIZE AND THE LIMITATIONS OF DIMENSIONS.

G. J. Churchward—Institution of Mechanical Engineers.

WE have reviewed elsewhere in this issue the valuable results of the locomotive testing plant of the Pennsylvania Railroad Company at the St. Louis exposition, and as a fitting complement to those experimental investigations we may note the paper of Mr. G. J. Churchward, the locomotive superintendent of the Great Western Railway, upon the subject of large locomotive boilers, presented at a recent meeting of the Institution of Mechanical Engineers:

"The modern locomotive question is principally a question of boiler. The great increase in the size of boilers, and in the pressures carried, which has taken place during the past few years has necessitated the reconsideration of the principles of design which have been worked out and settled during many years' experience with comparatively small boilers carrying low pressures. The higher temperatures incidental to the higher pressures have required the provision of much more liberal water spaces and better provision for circulation. Locomotive engineers have now apparently settled down to the use of one of two types of boiler for very large engines —the wide fire-box extending over the frames and wheels, and the long narrow box sloping up over the axles behind the main drivers."

In the United States the wide fire-box has been extensively employed, the larger grate area enabling inferior fuels to be burned, or, with better grade fuel enabling a greater steaming capacity to be secured. In Great Britain the narrower loading gauge, due to the smaller space between tracks, and the closer clearance at platforms, tunnels, bridges, etc., prevents the with the wide fire-box, and discusses the over the wheels, and the narrow box is necessarily employed.

Mr. Churchward refers to the difficulties experienced with leaky tubes in connection with the wide fire box, and discusses the possible remedies.

"All methods of tube-expanding have been tried, and also much wider spacing, even up to and over 1 in., without curing the trouble. The reduction of the depth of the fire-box, in order to get a long box sloping over the trailing-wheels of coupled engines, certainly increased the trouble from leakage of stays; but the alternative of a wide fire-box entails a much heavier engine for most of the types, and then apparently tube trouble is increased. The wide fire-box evidently requires a higher standard of skill in the fireman, for unless the grate is kept well and evenly covered, there is a tendency to have an excess of air, reducing efficiency and increasing tube trouble. With modern high pressures the temperature of evaporation is so much increased that the provision for circulation which was sufficient for the lower pressures formerly used is doubtless insufficient. Boilers in which this provision has been made

have shown a very marked reduction in tube and stay troubles.

"It is probable that in the wider boxes the main mass of the fire being so much nearer the tube-plate has a bad effect on the tubes, as the intensity of the temperature at the tube-plate must necessarily be much increased. The extra width of the box has enabled the tubes to be put much too near the sides of the barrel. When this is done, the water to feed up the spaces between the tubes near the back tube-plate has to be drawn almost entirely from the front of the barrel; and it is possible that in some cases the space left for this purpose is inadequate. It will probably be found that neglect of this consideration is the cause of three-fourths of the tube trouble. In some boilers, an effort has been made to provide for this upward circulation near the back tube-plate by leaving a space between the tubes and barrel, from top to bottom, of a sectional area equal to the combined area of the vertical spaces between the tubes at all points, with a balance to provide for the water coming back from the front of the barrel to feed the water-spaces of the fire-box."

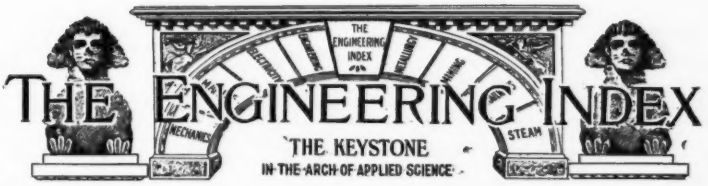
There is no doubt that the circulation of the water is an important element in the satisfactory performance of a boiler which is driven at the rate necessary in modern locomotive service. The nature and direction of the circulation is naturally dependent to a great extent upon the firing, and experiments have shown that a change in the firing will have a marked effect upon the circulation, even to the extent of entirely reversing the direction of the currents.

"The ratio of diameter to length of the tube undoubtedly has a most important bearing upon the steaming qualities of the boiler, and upon the efficiency of the heat absorption. This is more particularly noticeable when the boilers are being worked to the limit of their capacity. If 2-in. tubes, say, are employed in barrels 11 ft. to 12 ft. long, when the boiler is being forced the length is not sufficient to absorb the heat from the amount of gases that a 2-in. tube will pass, and overheating and waste result. The amount of tube-leaking which is experienced with modern wide boxes in America has brought up again the idea that the spacing should be wider—say, 1 in. instead of ¾ in.; but, from the investigations of a Master Mechanics' Committee, it appears that the wider spacing does not cure the trouble. It is clearly of no use to provide wider spaces for the upward current unless equivalent area is provided for the downcoming water.

"The gradual extension of the practice of making the top of the fire-box and casing flat, instead of round, is noticeable. On the Great Western Railway less trouble has been experienced with the flat-top fire-box than with the round-top, although no sling-stays of any kind are used. The flat-top has the important advantage of increasing the area of the waterline at the hottest part of the boiler, and so materially contributes to the reduction of foaming. This, combined with the coned connection to the barrel, has enabled the dome, always a source of weakness, to be entirely dispensed with and drier steam obtained. The liberal dimension of 2 ft. between the top of the fire-box and the inside of the casing no doubt contributed to the satisfactory result. The coned barrel connection, in addition to providing a greater area of water line, also gives a larger steam capacity, and, by the larger diameter being arranged to coincide with the line of the fire-box tube-plate, much more water space at the sides of the tubes is possible. On consideration of the great intensity of temperature at the fire-box plate, as compared with that at the smoke-box plate, the advantage of the arrangement is obvious."

An interesting point brought out by Mr. Churchward is the extent to which superheating may permit a reduction in boiler pressures to be made. It is understood that high pressures are necessary in order to enable the full benefits of compounding to be secured, but it is believed that by the introduction of the superheater a similar gain may be had, and at the same time the boiler pressure lowered from 225 pounds to 175 pounds per square inch, a fact which would aid materially in solving certain boiler troubles.

Mr. Churchward gives in his paper a series of illustrations of large locomotive boilers representing recent American and British practice, together with details of shell and fire-box construction.



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING

BRIDGES.

City Bridges.

Urban Bridges. Willis Whited. Discusses points in connection with the design and construction of city bridges, as distinguished from railroad bridges and highway bridges. Also discussion. 6500 w. Pro Engrs' Soc of W Penn—Feb., 1906. No. 75091 D.

Girders.

Girder Renewals, N. W. R., India. G. H. List. Illustrated account of heavy girder renewals under traffic on a single line. 800 w. Engr, Lond—Feb. 9, 1906. Serial. 1st part. No. 75069 A.

Iron Bridges.

Buildwas Bridge. An interesting account of the first two iron bridges of the world, built in the Severn valley; with special description and illustrations of this bridge built in 1796, and now being demolished, and to be replaced by a bow-

We supply copies of these articles. See page 155.

string lattice girder structure of the same span. 1500 w. Engr, Lond—Feb. 2, 1906. No. 75000 A.

Missouri River.

New Bismarck Bridge of the Northern Pacific. Illustrated description of a new bridge in North Dakota, built to replace one too light for present traffic. 800 w. R R Gaz—Vol. XI, No. 8. No. 75238.

Reconstruction of the Bismarck Bridge. Illustrated detailed description of the method of construction of a single-track bridge on the Northern Pacific Railway. 2500 w. Eng Rec—Feb. 24, 1906. No. 75264.

New York.

Erection of Falsework and Pier Pedestals, Island Span, Blackwell's Island Bridge. Illustrated description. 1400 w. Eng Rec—Feb. 24, 1906. No. 75260.

Secondary Members of the Island Span of the Blackwell's Island Bridge, New York. Illustrates and describes the design. 1600 w. Eng Rec—Feb. 10, 1906. No. 74976.

Reinforced Concrete.

The Pollasky Reinforced Concrete Bridge. Illustrated description of a recently completed bridge in California, which is one of the largest reinforced concrete bridges in the country. 1000 w. Eng Rec—Feb. 24, 1906. No. 75263.

Suspension.

The Elizabeth Eye-Bar Suspension Bridge at Budapest. Leon Ramakers. A handsomely illustrated description of the new bridge across the Danube at Budapest, with details of the erection and of the manufacture of the eye bars. 2500 w. Engineering Magazine—March, 1906. No. 75165 B.

CONSTRUCTION.

Chimneys.

A 350-Ft. Brick Chimney for Acid Chemical Gases. Theodore Lindeman. A brick chimney of unusual height recently completed at Newark, N. J., is illustrated and described in detail. 1800 w. Eng News—Feb. 15, 1906. No. 75016.

Recent American Chimney Practice. William Wallace Christie. An illustrated article considering types of chimneys for industrial purposes recently built. 2300 w. Cassier's Mag—Feb., 1906. No. 74-918 B.

Concrete.

Concrete Buildings in the United States. An illustrated detailed description of the applications of concrete to building construction, with the use of monolithic construction, and of concrete building blocks. 2000 w. Engr, Lond—Feb. 9, 1906. Serial. 1st part. No. 75067 A.

Concrete Mixers. J. S. Owens. Read before the Civ. & Mech. Engrs. Soc. Illustrates and describes various machines that have been devised, discussing the methods in use. 5000 w. Engng—Feb. 9, 1906. No. 75077 A.

Practical Notes on Concrete Building Construction. C. A. P. Turner. Abstract of a paper read before the Nat. Assn. of Cement Users. Remarks on materials and the reliability of the construction as compared with steel or timber, giving information from the writer's experience. 2700 w. Eng News—Feb. 1, 1906. No. 74808.

Concrete Blocks.

Causes of Failures in the Concrete Block Business. O. U. Miracle. Read at Con. of Nat. Assn. of Cement Users. Discusses the most serious dangers that seem to threaten this industry. 2500 w. Munic Engng—Feb., 1906. No. 75219 C.

The Selection of Portland Cement for Concrete Blocks. Richard K. Meade. Read before the Nat. Assn. of Cement Users. Points out the properties most requisite in Portland cement to be used for the manufacture of concrete blocks. 4500 w. Eng Rec—Feb. 10, 1906. No. 74975.

Waterproofing. J. L. Mothershead, Jr. Read at Con. of Nat. Assn. of Cement Users. Considers the waterproofing of concrete blocks. 1200 w. Munic Engng—Feb., 1906. No. 75217 C.

Excavation.

Difficult Excavation on the Hennepin Canal. An illustrated description of difficult work being executed by the U. S. Government on the Illinois and Mississippi ship canal. A Lidgerwood duplex traveling cableway of special design is used. 1200 w. Eng Rec—Feb. 10, 1906. No. 74973.

Fireproof.

Concrete and Hollow Tile. E. A. Trego. Illustrates and describes an example of the combined use of reinforced concrete and tile in fireproof construction. 1600 w. Cement Age—Feb., 1906. No. 75211.

Paper on Fireproof Construction. Owen Brainard. Read before the Ontario Assn. of Archts. Discusses the protection of steel skeleton buildings from both exterior and interior fires. 5800 w. Can Archt—Jan., 1906. No. 74927 C.

Floors.

Fire and Water Tests of Stone-Concrete and Cinder-Concrete Floors Reinforced with Corrugated Bars. Gives drawings of two forms of reinforced concrete floors, with report of tests made and the effects. 700 w. Eng News—Feb. 1, 1906. No. 74804.

We supply copies of these articles See page 155.

I. Fire Test of a Concrete Floor with Bays of Different Aggregates. II. The Resistance of Cement and Concrete Construction to Fire. Two papers discussed together editorially. The first is an abstract of report on experimental fire test made by the British Fire Prevention Committee. The second an abstract of a report presented at meeting of the Nat. Assn. of Cement Users. 6800 w. Eng News—Feb. 1, 1906. No. 74805.

Foundations.

Modern Foundation Construction with Concrete Piles (Ueber Neuere Fundierungsmethoden mit Betonpfählen). K. E. Hilgard. An illustrated description of the various systems of making and driving piles of reinforced concrete, showing the superiority of such foundations to wooden piles. Serial. Part I. 2000 w. Schweiz Bauzeitung—Jan. 20, 1906. No. 75125 B.

Piles.

Concrete Piles. David Lay. Illustrated description of the methods of manufacture and use of two leading types of concrete piles which are replacing wooden piles. 1800 w. Cement Age—Feb., 1906. No. 75212.

Manufacture and Use of Concrete Piles. Henry Longcope. Read at Con. of Nat. Assn. of Cement Users. Reviews the methods of pile construction tried at various times, especially the use of concrete. 2500 w. Munic Engng—Feb., 1906. No. 75218 C.

Reinforced Concrete.

Notes on Reinforced Concrete for Columns. James E. Howard. Considers the method of reinforcing by hooping, and the method of reinforcing by longitudinal bars, and their advantages. 2000 w. Eng Rec—Feb. 10, 1906. No. 74978.

Notes on the Friction of Iron Reinforcements in Beams (Beitrag zur Bestimmung des Gleitwiderstandes bei Balken aus Eisenbeton). G. Ramisch. A mathematical examination of the relation of the frictional resistance of reinforcing rods to the shearing resistance of the concrete, in beams reinforced with plain round or flat rods. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 26, 1906. No. 75123 D.

Reinforced Concrete on the Pacific Coast. H. A. Crafts. Brief illustrated description of the construction of a concrete and steel paper-mill building at Oregon City, Oregon. 1000 w. Sci Am—Feb. 24, 1906. No. 75084.

Steel for Reinforcement. A. L. Johnson. Read at Con. of Nat. Assn. of Cement Users. Discusses the resistance of the bars, some things tending to impair the bond, and fundamental principles. 2300 w. Munic Engng—Feb., 1906. No. 75214 C.

Stone Masonry.

Decay of Stone Masonry. J. W. Dougal, in the Glasgow *Herald*. Considers some causes of decay other than those best known, and the prevention. 1200 w. Ry & Engng Rev—Feb. 17, 1906. No. 75042.

Tunnels.

Construction of a Subway Tunnel Under the River Seine in Paris. E. Ommelange. Illustrated description of the construction of a single-tube, double-track tunnel, at an estimated cost of $3,100,000. 1400 w. R R Gaz—Vol. XL, No. 7. No. 75025.

The Detroit River Tunnel of the Michigan Central. Map and illustrated detailed description of the proposed railroad tunnel. Four methods are included in the specifications, any one of which may be used. 3000 w. R R Gaz—Vol. XL, No. 7. Serial. 1st part. No. 75021.

The Proposed Tunnel Under the Detroit River for the Michigan Central R. R. An illustrated description of plans worked out for this railroad tunnel, any one of which may be taken by bidders, or he may present plans of his own. 4000 w. Eng News—Feb. 15, 1906. No. 75019.

The Remarkable Tunnel Crossing of the Seine by Line 4, Metropolitan Railway of Paris. Brief illustrated description of tunnel formed of sections constructed as caissons and sunk end to end to grade. 1200 w. Eng News—Feb. 15, 1906. No. 75018.

MATERIALS OF CONSTRUCTION.

Bricks.

The Manufacture of Silico-Calcareous Bricks (Fabrication des Briques Silico-Calcaires). A description of the Röhrig and König process, with plan of works for the manufacture. The bricks have a high crushing strength and resistance to fire. 1200 w. 1 plate. Génie Civil—Jan. 27, 1906. No. 75113 D.

Cement.

A Large Portland Cement Plant at Bath, Pa. W. G. Tatnall. Illustrated detailed description of a plant designed for 2500 barrels output per day. 3000 w. Engr, U S A—Feb. 1, 1906. No. 74859 C.

Cement and Building Construction. C. A. P. Turner. Read at Con. of Nat. Cement Users. Discusses the importance of good workmanship in the use of this material, giving points that should secure good results. 2800 w. Munic Engng—Feb., 1906. No. 75215 C.

Flame Regulation in Cement Burning. Carleton Ellis. Discusses methods of cement burning and the causes of imperfect calcination. 2000 w. Cement Age—Feb., 1906. No. 75213.

We supply copies of these articles. See page 155.

The Testing and Use of Portland and Natural Cements. E. S. Larned. Read before the Nat. Assn. of Cement Users. Gives an expert's views, with details and results of experiments. 4300 w. Munic Jour & Engr—Feb. 7, 1906. No. 75006.

The Use of Cement for Farm Purposes. S. M. Woodward. Read at Con. of Nat. Assn. of Cement Users. Suggests some uses to which cement is applicable. 2000 w. Munic Engng—Feb., 1906. No. 75216 C.

Plaster.

Plaster Mining and Preparation in the Vicinity of Paris. Jacques Boyer. A fully illustrated account of the quarrying of the gypsum, and the practical operations of calcining and grinding plaster as conducted near Paris. 2500 w. Engineering Magazine—March, 1906. No. 75164 B.

Timber.

Experience in Creosoting Douglas Fir. P. F. Dundon. Extract from a paper read before the Wood Preservers' Assn. Gives the writer's experience with "Oregon pine," and timbers of the Pacific Coast. 600 w. Eng News—Feb. 8, 1906. No. 74917.

Recent Progress in the Protection of Structural Timber from Organisms of Decay (Neuere Ergebnisse in der Bekämpfung der im Hochbaue Auftretenden Holzzerstörenden Pilze). Basilius Malenkovic. Giving a list of the latest antiseptic preparations for the prevention of decay in timber, and a bibliography of recent writings on the subject. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 9, 1906. No. 75127 D.

MEASUREMENT.

Surveying.

Pathfinding for Canada's New Transcontinental Railway. H. V. Ross. Deals with the work of survey between Winnipeg and Moncton; which is to be built by the Dominion Government at an estimated cost of $100,000,000. Ills. 5500 w. Eng News—Feb. 1, 1906. No. 74803.

Public Land Surveys by Government Engineers in Indian Territory. Charles H. Fitch. A record of work done in 1895 in the survey and subdivision of nearly 31,000 square miles of land. 1200 w. Eng News—Feb. 8, 1906. No. 74916.

Stadia in Careful Work. Alfred H. Webb. Describes methods used by the writer, discussing variations in practice. 2000 w. Min Rept—Feb. 1, 1906. No. 74834.

MUNICIPAL.

Incinerating Plant.

The New York Rubbish Incinerating Plant. S. D. V. Burr. Illustrated detailed description of this plant, which is utilized in lighting the Williamsburgh Bridge. 2000 w. Ir Age—Feb. 8, 1906. No. 74904.

Pavements.

The Construction of Pavements in Chicago. Abstract of a paper by J. A. Moore, read before the Illinois Soc. of Engrs. & Survs. An explanation of the actual construction work; considers lines and grades, foundations, granite block, brick, asphalt, macadam, etc. 3500 w. Eng Rec —Feb. 3, 1906. No. 74863.

Refuse.

The Utilization of Refuse by Triple Sorting (Müllverwertung, Insbesondere nach dem Dreiteilungsverfahren). Dr. Hans Thiesing. A discussion of the refuse disposal problem, showing the advantages of a careful separation of the ashes, organic matter, and utilisable material from refuse, passing the second only to the destructor. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 19, 1906. No. 75122 D.

Sewage Disposal.

Combined Septic Tanks, Contact Beds, Intermittent Filters and Garbage Crematory, Marion, O. R. Winthrop Pratt. Illustrated detailed description of the sewage disposal plant and the garbage and refuse crematory. 5000 w. Eng News—Feb. 22, 1906. No. 75245.

The Sewage Disposal Plant at Downers Grove, Ill. W. S. Shields. Read before the Illinois Soc. of Engrs. & Survs. Illustrated description of a system of sand filtration following a septic treatment. 1600 w. Eng Rec—Feb. 3, 1906. No. 74865.

Waste.

The Disposal of Municipal Waste. William F. Morse. The first of a series of articles to appear monthly. Deals with systems and methods, with special reference to American conditions. 4500 w. Munic Jour & Engr—Feb. 7, 1906. Serial. 1st part. No. 75005.

WATER SUPPLY.

Filtration.

Construction and Operative Costs of the Sand Filters of the Amsterdam Waterworks (Constructie der Filters en Kosten van Zandfiltratie op het Pompstation Leiduin der Amsterdamsche Waterleiding). Jan van Poelgeest. With full details and plans of the filters, together with construction costs and cost of operation, filtering 30,000 cubic metres of water per day. 4000 w. De Ingenieur—Jan. 27, 1906. No. 75152 D.

The American System of Filtration at Mansourah, Egypt. Edmund B. Weston. Illustrated description of this plant, erected by the Jewell Export Filter Co. 1500 w. Eng Rec—Feb. 10, 1906. No. 74972.

The Water Filtering and Softening Works at Columbus, Ohio. Illustrated de-

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scription of a plant under construction, having features of interest which are an advance in works for inproved water supplies. 6000 w. Eng Rec—Feb. 24, 1906. No. 75259.

Water Filtration. J. M. Small. Deals with European methods of slow filtration, and American method of rapid, or mechanical filtration. 3200 w. Aust Min Stand—Jan. 3 and 10, 1906. Serial. 2 parts. No. 74979 each B.

Water Filtration and Purification at New Orleans. John Lewis Porter. Explains the character of the water and reviews the work formerly attempted to purify it, and the results, describing the proposed plant and method of treatment. 2500 w. Munic Jour & Engr—Feb. 7, 1906. No. 75007.

Irrigation.

A Diagram to Aid the Location of Small Irrigation Canals. Paul McGeehan. Gives diagram and table that have been used for laying the grade lines on the smaller irrigating ditches of the Klamath Project of the U. S. Reclamation Service. 600 w. Eng News—Feb. 1, 1906. No. 74806.

The Belle Fourche Irrigation Works, South Dakota. Walter W. Patch. An illustrated account of this interesting work, including a concrete diverting dam, a large canal, a long, high earth dam, a main and lateral canal system covering 90,000 acres, and a new township. 2500 w. Eng News—Feb. 22, 1906. No. 75248.

New York.

Report of the New York State Water Supply Commission. Extracts from the report, especially the state water supply system recommended in the report of Myron S. Falk. 2000 w. Eng News—Feb. 8, 1906. No. 74915.

Ozone.

Isolated Plants for the Sterilization of Water by Ozone (Einzelanlagen zur Sterilisation von Trink und Industriewasser durch Ozon). Dr. G. Erlwein. Describing a convenient arrangement of the Siemens & Halske apparatus to be operated in connection with the public electric lighting circuit. Serial. Part I. 2000 w. Gesundheits-Ingenieur—Feb. 10, 1906. No. 75151 B.

Pipe Joints.

Socket Joints for Cast-Iron Pipes (Gusseiserne Muffenrohrverbindungen). Gustav Simon. An illustrated study of the proportions of the bell or socket connections used in Germany for water and gas pipe of cast-iron. 2500 w. Stahl u Eisen—Feb. 1, 1906. No. 75136 D.

Reservoirs.

Reinforced-Concrete Reservoir at Fort Meade. Illustrated description of a 500,000 gal. reservoir with a flat slab roof carried by beams and girders supported on square reinforced-concrete columns. 1800 w. Eng Rec—Feb. 10, 1906. No. 74974.

Water Works.

The New Water Works of Port Elizabeth, Cape of Good Hope. Illustrations and general information concerning important works in course of construction in South Africa. 1100 w. Eng Rec—Feb. 3, 1906. No. 74862.

Wisconsin.

The Sources of Water Supply in Wisconsin. William Gray Kirchoffer. Describes the sources of both surface and ground waters from which cities and villages are supplied. Illus. 21000 w. Bul Univ of Wis, No. 106—Jan., 1906. No. 75297 E.

WATERWAYS AND HARBORS.

Canal Haulage.

Electric Canal Haulage. Frank C. Perkins. An illustrated description of an equipment on trial in Germany, with short accounts of other systems. 1500 w. Ir Age—Feb. 15, 1906. No. 75001.

Colorado River.

The Break of the Colorado River into the Imperial Valley and Salton Sink. An account of the flood and damage caused by cutting a short emergency irrigation canal from the lower Colorado River. Map. 3500 w. Eng News—Feb. 22, 1906. No. 75249.

Danube.

Improvements in the Navigation of the Bavarian Danube (Die Verbesserung der Schiffbarkeit der Bayerischen Donau). With map and profile, showing the canalisation works now in progress on the Danube from Saal to Ulm. 1500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 20, 1906. No. 75131 D.

Irrigation.

Winning the West. C. J. Blanchard. An illustrated account of the progress of the reclamation service in reclaiming the desert. 5700 w. Nat Geog Mag—Feb., 1906. No. 75201 C.

Locks.

Formulas for the Time Required to Fill and Empty Canal Locks (Einfache Formeln für die Zeitdauer des Füllens und Entleerens von Kammerschleusen). Dr. P. Kresnik. A discussion of methods of economizing water for canal locks by the use of storage basins, with formulas for computing the rate of filling and emptying under such conditions. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 9, 1906. No. 75128 D.

Panama.

Plain Facts about the Panama Canal. John F. Wallace. A straight talk about

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the real conditions of affairs on the isthmus, showing what red tape is costing, and emphasizing the great advantages of letting the work out by private contract. 5000 w. Engineering Magazine—March, 1906. No. 75161 B.

Testimony of John F. Stevens, Chief Engineer of the Isthmian Canal Commission, before the Senate Investigating Committee. Extracts containing the matter of most interest to engineers. 11000 w. Eng News—Feb. 8, 1906. No. 74913.

The Panama Canal. Hon Theodore P. Shonts. An address to the Commercial Club of Cincinnati, explaining the experiments with foreign labor, the arrangements for transportation facilities, and other questions. Ills. 5000 w. Nat Geog Mag—Feb., 1906. No. 75200 C.

The Report of the Board of Consulting Engineers for the Panama Canal. A summary of the report, with lengthy abstract of the majority report, favoring the sea-level canal, and recommendations of the Canal Commission approving the 85-ft. lock level plan. Also official reports on the plans. Ills. 16800 w. Eng News—Feb. 22, 1906. No. 75247.

River Regulation.

Regulation Works in Upper Austria (Die Gewässerregulierung in Oberösterreich). S. Stern. Illustrating the improvement works which have been conducted on the Ager and its tribuaries in the districts of St. Georgen, Berg, and Vöcklamarkl, upper Austria. 3000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 27, 1906. No. 75132 D.

Sedimentation.

Sedimentation: Its Relation to Drainage. J. W. Dappert. Abstract of a paper presented at meeting of the Illinois Soc. of Engrs. & Survs. A study of the sedimentation in drainage work, with a statement of the writer's conclusions. 3000 w. Eng News—Feb. 1, 1906. No. 74810.

MISCELLANY.

Sand Waves.

Sand Waves and Their Work. Day Allen Willey. An illustrated article describing the formations of sand dunes, and the effect of winds, and the methods that have been tried to check the movement of the sand. 1800 w. Sci Am—Feb. 24, 1906. No. 75086.

Specifications.

Decision on Appeal in the Manhattan Bridge Contract Case. Also editorial. Gives the main parts of the opinion that specifications on public contracts must accurately define the work. 5400 w. Eng News—Feb. 1, 1906. No. 74807.

ELECTRICAL ENGINEERING

COMMUNICATION.

Space Telegraphy.

Advantageous Use of Highly Magnetic Metal in Radiation Conductors. James Foster King. Gives deductions from the effects obtained in some qualitative experiments along this line. 1400 w. Elec Wld —Feb. 10, 1906. No. 74971.

Braun's New Method of Directing Wireless Messages. A. Frederick Collins. Describes a new method for directing wireless messages, based on the theory of wave intensification and rarefaction by interference. 1200 w. Sci Am—Feb. 3, 1906. No. 74811.

The De Forrest Syntonic System of Wireless Telegraphy. A. Frederick Collins. Describes the improvements that have been introduced in this system, especially the use of Lecher's wires as a tuning and syntonizing device. Diagrams. 4200 w. Sci Am Sup—Feb. 10, 1906. No. 74955.

Transmitting Distance in Wireless Telegraphy. Capt. L. D. Wildman. Discusses the formula deduced by J. Erskine-Murray for indicating the limit of distance in transmission, and gives the writer's opinion in regard to the influence of the weather at the sending station, based on experience in Alaska. 1000 w. Elec Wld —Feb. 10, 1906. No. 74970.

Telephony.

A Review of Telephone Patents Issued in 1905. Edward E. Clement. A brief commentory on the most interesting and significant of these patents. 4000 w. Elec Rev, N Y—Feb. 3, 1906. Serial. 1st part. No. 74825.

The Post-Office Telephone System. Illustrated description of the new "City" exchange in London. 2500 w. Elec Rev, Lond—Jan. 26, 1906. Serial. 1st part. No. 74876 A.

DISTRIBUTION

Boosting.

A New Method of Automatic Boosting. Max J. E. Tilney. Abstract of a paper read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Describes a system of automatic regulation on the shunt field, dealing only with the apparatus as applied to boosters and batteries. Also

We supply copies of these articles. See page 155.

discussion. 5000 w. Elect'n, Lond—Jan. 26, 1906. No. 74879 A.

Cables.

The Manufacture, Application, and Distribution of Electric Cables for Collieries. George G. L. Preece. An illustrated article dealing exclusively with electric cables for colliery working. Describes various types of cable, considers the system and best form and method of erecting. 8800 w. Ir & Coal Trds Rev—Jan. 26, 1906. No. 74883 A.

Rectifier.

Mercury Arc Rectifier for Charging Storage Batteries. A Frederick Collins. Illustrated description of the General Electric Co.'s mercury arc rectifier. 1200 w. Sci Am—Feb. 17, 1906. No. 75026.

Transformers.

Large Transformer Units for Power Distribution. J. N. C. Holroyde. Explains the work for which these large transformers are employed, and illustrates and describes types in use, methods of cooling, etc. 2000 w. Elec Engr, Lond—Jan. 26, 1906. Serial. 1st part. No. 74874 A.

Wales.

Electric Power Distribution in North Wales. Outlines the general features of this scheme and gives illustrated description of interesting details. The system is driven entirely by water power, and will transmit power over considerable distances at extra high pressure. 1200 w. Elect'n, Lond—Jan. 26, 1906. Serial. 1st part. No. 74877 A.

Wiring.

The Electric Wiring of Small Buildings during Course of Erection. R. Robson. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Considers the means of getting a good installation at small expense, especially in small dwellings. 4000 w. Elec Engr, Lond—Feb. 9, 1906. No. 75060 A.

Wiring with Wooden Mouldings. Louis J. Auerbacher. An illustrated article giving suggestions for the selection of material and laying out of the work, and the proper methods of executing. 2000 w. Elec Wld—Feb. 3, 1906. No. 74907.

ELECTRO-CHEMISTRY.

Calculations.

Electrochemical Calculations. Joseph W. Richards. Developing formulas for the values of electrical energy in thermal and mechanical units for the expression of the effects of electrical currents. 3500 w. Serial. Part I. Jour Frank Inst—Feb., 1906. No. 75094 D.

Carborundum.

The Carborundum Furnace. F. A. J. Fitzgerald. With longitudinal and transverse sections of the electric furnace for the production of silicon carbide, and a discussion of the efficiency of its operation. 1700 w. Electrochem & Met Ind—Feb., 1906. No. 74910 C.

Current Density.

The Rôle of Current Density in Electrolytic and in Electric Furnace Processes. Discusses the rôle of current density in each case, and shows the necessity of watching it and adjusting it to the needs of the moment. 2000 w. Elec-Chem & Met Ind—Feb., 1906. No. 74908 C.

Electro-Metallurgy.

Electro-Metallurgy in 1905. A survey of the progress in the various branches of electro-metallurgy in 1905. 2000 w. Engr, Lond—Jan. 26, 1906. Serial. 1st part. No. 74886 A.

Nitrates.

The Electric Production of Nitrates from the Atmosphere. Prof. Silvanus P. Thompson. A lecture at the Royal Inst. Explains and demonstrates the ingenious process for the "fixation" of nitrogen devised by Prof. Birkeland and developed with the assistance of Herr Eyde, giving figures of cost, and showing its industrial importance. 6800 w. Elect'n, Lond—Feb. 9, 1906. No. 75062 A.

The Utilization of Atmospheric Nitrogen (Utilisation de l'Azote Atmosphérique). A Boileau. A review of the various electro-chemical methods which have been proposed for the fixation of atmospheric nitrogen for the production of ammonia and nitrates. 1800 w. Génie Civil—Jan. 20, 1906. No. 75112 D.

Progress.

Electro-Chemical and Electro-Metallurgical Progress in 1905. F. S. Spiers. Reports steady and satisfactory progress in both industries, discussing the developments. 2200 w. Elec Rev, Lond—Feb. 16, 1906. Serial. 1st part. No. 75273 A.

ELECTRO-PHYSICS.

Electrons.

Mechanical Technical Discussions (Mechanisch-Technische Plaudereien). Dr. G. Holzmuller. A review of the latest electrical theories, with especial reference to the theory of electrons. Two articles. 7500 w. Zeitschr d Ver Deutschr Ing—Jan. 20, 27, 1906. No. 75101 Each D.

Gravitation.

The Problem of Gravitation. Charles Morris. A study presenting briefly some of the hypotheses which have been offered in explanation. 5500 w. Jour Fr Inst—Feb., 1906. No. 75093 D.

High Tension.

Simple Experiments with Currents of High Tension and Frequency. Thomas

We supply copies of these articles. See page 155.

R. Hopper. Describes a few examples of simple experiments which can be performed with inexpensive apparatus. 1400 w. Sci Am Sup—Feb. 17, 1906. No. 75029.

Radio Activity.

The Diminution of the Radio-Activity of Polonium with the Lapse of Time, (Sur la Diminution de la Radioactivité du Polonium avec le Temps) Mme. Curie. Deriving an exponential equation for the rate of diminution, with experimental values for the constant. 1500 w. Comptes Rendus—Jan. 29, 1905. No. 75117 D.

The Duration of the Discharge in an X Ray Tube (Sur la Durée de la Décharge dans un Tube à Rayons X). André Broca. Description of experimental demonstration that the duration of the discharge is about 0.0005 second. 1000 w. Comptes Rendus—Jan. 29, 1906. No. 75116 D.

Rectifier.

The Rectification of Alternating Currents. P. Rosling. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. and of discussion. Explains the operation of the electrolytic rectifier and the mercury arc rectifier. 3500 w. Elect'n, Lond—Feb. 9, 1906. No. 75063 A.

Transformer.

Simple Transformer for Amateur Use. Edmund S. Smith. Describes and illustrates a small transformer easily built by any one familiar with tools, at a cost of about $3.50 for materials. 1000 w. Sci Am Sup—Feb. 17, 1906. No. 75028.

GENERATING STATIONS.

Alternators.

The Design of Alternators, with Reference to Voltage Variations (Die Dimensionierung der Wechselstrommaschinen mit Rücksicht auf Spannungsänderung). W. Wittek. Deriving formulas for the dimensions of the various details of alternators for given conditions of efficiency and temperature. 2500 w. Elektrotech u Maschinenbau—Feb. 4, 1906. No. 75144 D.

Central Stations.

A Modern Central Station Plant. Illustrated detailed description of the "No. 3" steam-operated station of the Edison Electric Company of Los Angeles, Cal. 1500 w. Power—Feb, 1906. No. 74896 C.

Combined Plants.

The Economy of Combined Railway and Lighting Plants. Read at meeting of the N. W. Elec. Assn. Ernest Gonzenbach. Considers some of the commercial and economical features in the operation of combined railway and lighting plants. 3000 w. St Ry Rev—Feb. 15, 1906. No. 75231 C.

The Economy of Combined Railway and Lighting Plants. Ernest Gonzenbach. Abstract of a paper read before the N. W. Elec. Assn., at Chicago. Discusses the saving to be effected by combining railway and lighting service. 900 w. Elec Wld—Jan. 27, 1906. No. 74792.

Developments.

Modern Electrical Developments. G. F. Metzger. Abstract of a paper before the Manchester Assn. of Engrs. Deals with electric supply as given from central stations or private plants for lighting, tramway, or motive power. 3500 w. Mech Engr—Feb. 3, 1906. No. 74986 A.

Hydro-Electric.

Hydro-Electric Plant at Montereale. Illustrates and describes a plant which utilizes the energy of the Cellina River, and is intended to transport electricity for lighting and power purposes to Venice and surrounding districts. 2000 w. Engr, Lond—Feb. 9, 1906. No. 75066 A.

The Hydro-Electric Station at Entraygues (L'Usine Hydro-Electrique d'Entraygues). P. Cafourier. Illustrated description of a station on the Argens, in the south of France, deriving about 3000 h. p. for delivery to Toulon and its environs. 3500 w. 1 plate. Génie Civil—Feb. 3, 1906. No. 75114 D.

The Kaiser Hydro-Electric Station (Die Kaiserwerke). S. Herzog. An illustrated description of the plant at Kufstein, in Tyrol, arranged to develop 3600 h. p. by tapping the Hintersteinsee. Serial. Part I. 3000 w. Elektrotech u Maschinenbau—Feb. 11, 1906. No. 75147 D.

Isolated Plants.

Isolated Plants. H. L. Woolfenden. Gives facts concerning a typical office-building plant, and its features of interest. 2300 w. Elec Rev, N Y—Feb. 17, 1906. No. 75033.

Mechanical Plant of the New Wanamaker Store in New York. Illustrated detailed description of a plant to provide for the generation of electricity for lighting and power purposes, and also the heating, ventilating and general mechanical service of one of the largest department stores in the world. 4500 w. Eng Rec—Feb. 24, 1906. Serial. 1st part. No. 75261.

The Heating and Lighting Plant at Bryn Mawr College. George C. G. Gray. Illustrated detailed description of a central plant to serve a group of buildings. 3800 w. Eng Rec—Feb. 17, 1906. No. 75054.

The Mechanical Plant in the Tietz Store in Munich. Notes and illustrations from an article by Julius Weil, in the *Zeit-*

schrift of the Soc. of German Engrs. Diesel engines are used. 1800 w. Eng Rec —Feb. 10, 1906. No. 74977.

Springfield, Ill.

The Springfield, Ill., Light, Heat and Power Co.'s Station and System. Illustrated detailed description. 3800 w. Elec Wld—Feb. 3, 1906. No. 74906.

Supervision.

The Proposed Official Supervision of Electric Plants (Die Beabsichtige Staatliche Ueberwachung Elektrischer Anlagen). H. Passavant. A discussion of the proposition to subject electrical installations in Germany to official regulations and supervision. 4500 w. Zeitschr d Ver Deutscher Ing—Jan. 20, 1906. No. 75103 D.

Supply.

Central Stations versus Isolated Plant. Albert Yost. Discusses the economy of the service, and the conditions under which a private plant will pay. 2000 w. Power. Feb., 1906. No. 74902 C.

Switzerland.

The Installations of the Vaudoise Motor Power Company at the Lakes of Joux and Orbe, Switzerland. Franz Koester. Illustrates and describes interesting details of the installation. 3000 w. Elec Rev, N Y—Feb. 10, 1906. No. 74962.

LIGHTING.

Arc Lamps.

Flame Arc Lamps. Leonard J. Pumphrey. An illustrated article presenting the advantages of these lamps, claiming great efficiency, and describing their construction. 2800 w. Elec Engr, Lond—Feb. 2, 1906. No. 74990 A.

Incandescent.

The New Metallic Filament Lamp of Dr. Hans Kuzel (Einiges über die Neuen Metallfaden Lampen nach Verfahren Dr. Hans Kuzel). John. Kremenezky. Data and results of tests upon a new filament of which the composition is not given. The current consumption is about 1 watt per Hefner candle, with a life of 1,500 hours. 1500 w. Elektrotech u Maschinenbau—Feb. 4, 1906. No. 75146 D.

Interiors.

The Lighting of Dining and Bed Rooms. J. R. Cravath and V. R. Lansingh. Discusses good and bad arrangements for the lighting of these rooms by electricity. Ills. 3800 w. Elec Wld—Feb. 3, 1906. No. 74905.

Progress.

The Progress in Electric Lighting. Leon Gaster. Describes the present manufacture of carbon filament lamps, discussing the quality, candle power, etc., the proper selection of lamps, shades, improved filaments and other marks of progress. Discussion. 11800 w. Jour Soc of Arts—Feb. 9, 1906. No. 75064 A.

Shops.

Store Lighting. E. Leavenworth Elliott. Points in showing different wares to advantage, and the means of securing efficiency in store lighting and the lighting of show windows. 1500 w. Cent Sta—Feb, 1906. No. 74957.

Waste.

Waste in Incandescent Electric Lighting and Some Suggested Remedies. George Wilkinson. Abstract of a paper before the Leeds Loc. Soc. of the Inst. of Elec. Engrs. Notes instances of waste that have come under the writer's notice, suggesting remedies. 4500 w. Elect'n, Lond—Feb. 16, 1906. No. 75278 A.

MEASUREMENT.

Instruments.

Iron-Cored Alternate-Current Instruments. W. E. Sumpner. Abstract of a paper in the *Journal* of the Inst. of Elec. Engrs. (England). Discusses the difficulties in regard to the accurate working of such instruments, the errors due to incorrect phase relations, etc. 3300 w. Elect'n, Lond—Feb. 2, 1906. No. 74989 A.

Some Recent Electrical Measuring Instruments. Kenelm Edgcumbe. A review of recent progress in ampere gauges, wattmeters, photometers, etc. Ills. 3500 w. Elec Engr, Lond—Feb. 9, 1906. Serial. 1st part. No. 75059 A.

Meters.

The Proper Handling of Consumers' Meters. George H. Barrett. Abstract of a paper read before the N. W. Elec. Assn., at Chicago, and of the discussion. Gives suggestions for the care and testing of meters, and ways of satisfying customers as to their accuracy. 2000 w. Elec Wld—Jan. 27, 1906. No. 74791.

Wattmeters.

Series Transformers for Wattmeters. Lancelot W. Wild. Explains the object of this arrangement, and discusses the need of careful designing, describing a design for the Westminister Electrical Testing Laboratory. 1800 w. Elect'n, Lond—Feb. 16, 1906. No. 75275 A.

TRANSMISSION.

Transmission Circuits.

Induction in Transmission Circuits. Charles F. Scott. An elementary consideration of the physical basis underlying self induction and mutual induction. 3000 w. Elec Jour—Feb, 1906. No. 75269.

MOTORS.

Cranes.

Crane Motors and Controllers. Claude W. Hill. Gives some of the more common

methods of specifying, and the method of calculation to ascertain the load and time which shall produce a rise in temperature equal to that produced in the usual way of working, discussing the requirements of controllers. Tables and diagrams. 4000 w. Inst of Elec Engrs—Feb. 8, 1906. No. 75061 D.

Induction Motors.

A Contribution to the Theory of the Single-Phase Induction Motor. Val A. Fynn. A study of the theory of the asynchronous single-phase induction motor, showing the reasons for its operation and its relation to the continuous-current motor. 2300 w. Elec Rev, Lond—Feb. 9, 1906. Serial. Part I. No. 75081 A.

Armature Reaction in Polyphase Motors (Ankerrückwirkung in Drehstromgeneratoren). J. K. Sumec. Deriving formulas for computing the excitation, with practical applications to the design of motors. Two articles. 6000 w. Elektrotech u Maschinenbau—Jan. 21, 1906. No. 75143 Each D.

Magnetic Field in the Induction Motor. A. S. M'Allister. Quotes statements made in an article published in this *Journal* in Nov., 1904, and discusses the facts upon which the statements are based, to show that the space distribution of the revolving magnetic flux follows a line law, and to outline a method by which the implied considerations can be utilized in the treatment of induction motor phenomena. 3500 w. Sib Jour of Engng—Feb., 1906. No. 75270 C.

The Magnetism in Induction Motors. H. F. and H. W. Connell. Gives an outline of an investigation undertaken to determine how nearly the present commercial induction motor follows the theoretical laws regarding the impressed e. m. f. wave form and its relation to the resultant wave form of the flux; also editorial. 1800 w. Elec Wld—Feb. 24, 1906. No. 75266.

Winding Faults in Induction Motors. E. B. Raymond. Shows how by taking simple readings the winding condition can be determined and a correction applied. 1700 w. Engr, U S A—Feb. 15, 1906. No. 75058 C.

Inter-Pole Motor.

The Reincarnation of an Electrical Idea. Frank J. Sprague. An explanation of the value of the inter-pole motor in connection with direct-current operation. 2000 w. Elec Wld—Feb. 24, 1906. No. 75265.

MISCELLANY.

Lectures.

Elementary Lectures on Electrical Engineering. This first of a series of articles explains some of the fundamental principles. Ills. 1200 w. Power—Feb., 1906. Serial. 1st part. No. 74899 C.

Review.

The Electrotechnical Industries in the Year 1905 (Die Elektrotechnische Industrie im Jahre, 1905). Emil Honigmann. A general review of the progress of the electrical industry in Europe, with special reference to developments in Austria-Hungary. Tabulated comparisons for 1904 and 1905 are given. Serial. Part I. 4000 w. Elektrotech u Maschinenbau—Jan. 14, 1906. No. 75141 D.

Statistics.

The Electric Power Companies. The annual sheet of statistics of the electric power companies of the United Kingdom, with editorial. 3000 w. Elect'n, Lond—Jan. 26, 1906. No. 74878 A.

INDUSTRIAL ECONOMY

Agriculture.

Agricultural Machinery in the Beginning of the Twentieth Century (Le Materiel Agricole au Debut du XX Siecle). Max Ringelmann. An exhaustive review of the application of engineering to the development of agriculture, including the development of agricultural machinery and appliances during the nineteenth century, and their influence upon the status of agricultural labor, and national economy. 15,000 w. Bull Soc d'Encour—Oct., Nov., 1905. No. 75180 each G.

Apprentices.

Technical Training and the Apprenticeship Question. (L'Enseignement Professionnel et la Question de l'Apprentissage). M. Alfassa. A study of apprenticeship in France, in connection with technical instruction, giving a summary of the plan for the education of apprentices adopted in France by the Conseil Superieur du Travail. 8000 w. Bull Soc d'Encour—Nov., 1905. No. 75181 G.

Contracts.

The "Indiana" Claim in the Court of Claims. George A. King and William B. King. A review of this suit which is of importance to contractors with the U. S. Government. 2400 w. Eng Rec—Feb. 17, 1906. No. 75056.

We supply copies of these articles. See page 155.

Copper Trade.

The World's Copper Trade in 1905. Horace J. Stevens. A review of the year showing much the largest production of copper ever known. 4500 w. Min Wld—Jan. 27, 1906. No. 74777.

Costs.

The Estimation of Costs. Abstract of a paper by A. W. Farnsworth, read before the Coventry Engng. Soc. Interesting suggestions concerning the employment of better men for cost-keeping. 2500 w. Eng Rec—Feb. 3, 1906. No. 74864.

Education.

A Municipal School of Marine Engineering. Editorial on the Poplar School, recently opened in London. 2800 w. Engng—Jan. 26, 1906. No. 74895 A.

Investigations and Commercial Tests in Connection with the Work of an Engineering College. Prof. D. S. Jacobus. Address before the Am. Assn. for the Adv. of Science. Presents the advantages and disadvantages of research work and outside work. 3200 w. Am Mach—Vol. 29. No. 6. No. 74937.

Laboratory Training. C. H. Benjamin. An illustrated article discussing the aim of laboratory work and how best to make the work of benefit. Describes briefly the power laboratory of the Case School, indicating how it is being used. 2000 w. Mach, N Y—Feb, 1906. No. 74800 C.

The Application of Science to Industry. Editorial review of the Final Report of the Departmental Committee on the Royal College of Science, etc. 4000 w. Engng—Feb. 9, 1906. No. 75076 A.

The Dresden Technical High School. Begins an illustrated detailed description of the new mechanical department and its equipment. 1800 w. Engr, Lond—Jan. 26, 1906. Serial. 1st part. No. 74890 A.

The Technical Training of Apprentices. Prof. Sir W. Ripper. Discusses the standing of technical education in England, and the attitude of employers. 2200 w. Engr, Lond—Feb. 9, 1906. No. 75070 A.

Germany.

The American and the German Peril. Louis J. Magee. The third and concluding article treats of American trade methods as tested by German experience. 2500 w. Engineering Magazine—March, 1906. No. 75162 B.

Industry.

The Importance of Industrial Studies for the Work of the Engineer (Die Bedeutung Wirtschaflicher Studien für den Stand der Ingenieure). H. Kollman. A review of the relation of engineering work to the economic and industrial development of a nation. 4000 w. Zeilschr d Ver Deutscher Ingenieure—Jan. 20, 1906. No. 75104 D.

Labor.

Method of Exporting Chinese Coolies to the Transvaal. An explanation of the system established by the Chinese Government, for the enlistment of coolies for work in the mines of the Transvaal. 2200 w. Min & Sci Pr—Jan. 27, 1906. No. 74846.

Laboratory Appliances.

Labor-Saving Appliances in the Laboratory. Edward Keller. Describes and illustrates a number of improved methods and apparatus introduced in the newly equipped assay laboratory of the Anaconda Copper Mining Co. in Baltimore. 2800 w. Jour Fr Inst—Feb, 1906. No. 75092 D.

Metric System.

The Metric System Fallacy. W. M. McFarland. Abstract of testimony on this subject, given before the American Congressional Committee on Coinage, Weights and Measures. 3500 w. Cassier's Mag—Feb, 1906. No. 74919 B.

Production.

Concentration in Manufactures. Editorial discussion of the effect of such systems upon economy of production. 2000 w. Engng—Feb. 16, 1906. No. 75288 A.

Profit-Sharing.

Shop Betterment and the Individual Effort Method of Profit-Sharing. Harrington Emerson. Discusses the shop problem of the present, and explains a system of profit-sharing believed to include all that is best in other methods, and to exclude much that is objectionable. 4000 w. Am Engr & R R Jour—Feb, 1906. No. 74853 C.

Valuation.

The Valuation of Machinery for Rating Purposes. Frederick Marshall. Abstract of a paper read before the Surveyor's Inst. Discusses British law on the rating of machinery, citing several cases. 3000 w. Ir & Coal Trds Rev—Feb. 16, 1906. No. 75293 A.

Works Management.

The Square Deal in Works Management. O. M. Becker. The third article discusses the attempts which have been made to better the physical condition of workers, by providing lunch rooms, seats, proper sanitary conveniences, etc., in many large establishments. 6000 w. Engineering Magazine—March, 1906. No. 75163 B.

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MARINE AND NAVAL ENGINEERING

Collier.

A 12,000 Ton Floating Collier (Schwimmender Kohlenspeicher für 12,000 t.). W. Kaemmerer. An illustrated description of coaling apparatus built by the Temperly Transporter Co., for the harbor of Portsmouth. 1200 w. Zeitschr d Ver Deutscher Ing—Jan. 27, 1906. No. 75106 D.

Docks.

Docks for Torpedo Boats at the Imperial Yards at Kiel (Dockanlage für Torpedoboote auf der Kaiserlichen Werft Kiel). Ph. von Klizing. An illustrated description of the new floating docks built by the Howaldtswerk for the special purpose of overhauling torpedo boats. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 20, 1906. No. 75102 D.

Education.

See Industrial Economy.

Engines.

See Mechanical Engineering, Steam Engineering.

Ferry-Boat.

Petrol Motor-Driven Ferry Boat "Swallow." Detail drawings with description. 900 w. Engng—Feb. 9, 1906. No. 75074 A.

Liner.

The New P. & O. Liner Dongola. Benjamin Taylor. Illustrates and describes the latest vessel designed for the Eastern mail service, combining speed and spacious passenger accommodations. 1700 w. Marine Engng—Feb, 1906. No. 74831 C.

Liquid Fuel.

Liquid Fuel for Naval and Marine Uses. George Melville. Gives a résumé of some of the important points covered by the report of the Board appointed to investigate the liquid fuel problem in its application to marine uses. 3000 w. Sci Am Sup—Feb. 3, 1906. Serial. 1st part. No. 74813.

Paddle Steamships.

Early American Paddle Steamships. Gives a list of the principal paddle steamships built in the United States, with information concerning them. 1000 w. Naut Gaz—Feb. 1, 1906. No. 74830.

The American Paddle Steamship Golden Age. Illustrated description of a vessel built in New York in 1853, which made at that time record-breaking trips out to Australia and return across the Pacific. 2200 w. Naut Gaz—Feb. 1, 1906. No. 74829.

Screw Propellers.

The Screw Propeller Controversy. James Howden. Explains why the subject is brought up and reviews the writer's previous papers and the discussions that followed their presentation, defending the writer's views. 16600 w. Trans Inst of Engrs & Shipbuilders in Scotland—Jan. 23, 1906. No. 75296 D.

Shaft Torsion.

Torsion Indicator Diagrams of Marine Engines. A study of the investigations recently made in Germany upon the torsion of screw propeller shafts, with diagrams, showing the nature of the stresses. 3000 w. Engng—Jan. 26, 1906. No. 74892 A.

Shipping.

Shipping on the Great Lakes. W. I. Babcock. Lecture at the Inst. of Technology, Boston. Describes the physical characteristics of the lakes and connecting waters, and the classes of boats the service requires, the immense amount of business, the methods of loading and unloading, etc. 6000 w. Marine Rev—Feb. 22, 1906. No. 75244.

Shipping Bill.

Text of Shipping Bill. Gives the full text of the new ship subsidy bill which passed the Senate of the United States on Feb. 14. 3500 w. Naut Gaz—Feb. 22, 1906. No. 75243.

Shipyards.

London Works, Renfrew. An illustrated description of works for building dredgers, barges, and dredger plants generally, with illustrated types produced. The works have recently been extended and rearranged. 2700 w. Engr, Lond—Feb. 16, 1906. No. 75280 A.

Scott's Shipbuilding and Engineering Works at Greenock. An illustrated article giving the history and description of an industry maintained for 200 years by one family, and in one locality. 6000 w. Engng—Feb. 9, 1906. No. 75071 A.

Steamers.

A Wooden Passenger Steamer for Onedia Lake. Illustrates and describes a new passenger steamer, and its power equipment. 1600 w. Marine Engng—Feb, 1906. No. 74832 C.

Steam Trawler.

The New Steam Trawler Spray. Illustrated description of a typical North Sea steam trawler introduced among the fleets of Boston and Gloucester deep-sea fisher-

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men, with an account of the method of catching the fish. 2000 w. Naut Gaz—Feb. 1, 1906. No. 74828.

Submarines.

Submarine Navigation. Sir William H. White. An address before the Roy. Inst. of Gt. Britain. Refers to efforts made as early as 1860, and reviews the progress and development, especially the modern types. The conditions to be met are described, and the equipment of such vessels. 5000 w. Pop Sci M—March, 1906. No. 75232 C.

Torpedo Boats.

The Future of Torpedo Craft. Archibald S. Hurd. Reviews the development of torpedo boat destroyers, illustrating types built, and discussing their value in warfare, and indicates some changes in construction of torpedo craft due to observations made during the Russian-Japanese war. 4000 w. Cassier's Mag—Feb, 1906. No. 74920 B.

The Yarrow-Napier Torpedo Boat. Illustrations, with description of a second-class motor torpedo boat recently launched 1100 w. Auto Jour—Jan. 27, 1906. No. 74869 A.

Turbines.

The History of the Marine Turbine. Reviews the history from the Turbinia of 1894 to the Carmania of 1905. Ills. 2800 w. Mach, N Y—Feb, 1906. No. 74801 C.

Warships.

The "Dreadnought." Editorial review of this recently launched vessel, said to be the most powerfully armed, the best protected, and the fastest battleship ever laid down. 4000 w. Engng—Feb. 9, 1906, No. 75075 A.

MECHANICAL ENGINEERING

AUTOMOBILES

Chassis.

A Discussion of the 1906 Chassis. Forrest R. Jones. Discusses in detail the present automobile practice, especially in pleasure cars of the larger size. 3500 w. Automobile—Feb. 8, 1906. Serial. 1st part. No. 74928.

The 40 h. p. Crossley-Critchley Car. Illustrates and describes a fine example of English automobile engineering, shown at the Edinburgh Exhibition. 1400 w. Autocar—Feb. 3, 1906. No. 74982 A.

Exhibition.

New Exhibits in Cars at Chicago. Illustrated detailed description of cars displayed which were not shown at New York. 6000 w. Automobile—Feb. 15, 1906. No. 75008.

The Progress of Automobilism in 1905 (Les Progrès de l'Automobilisme en 1905). F. Drouin. A fully illustrated description of the Salon exhibition of the Automobile Club of France, with details of novelties in construction. Three articles. 6000 w. Génie Civil—Jan. 20, 27, Feb 3, 1906. No. 75111 each D.

Ignition.

The Lacoste Magneto. Explains the construction and operation of this high-tension, self-contained magnet. Ills. 1600 w. Autocar—Jan. 27, 1906. No. 74871 A.

Lubrication

Lubrication and Its 1906 Forms. An illustrated article describing the oilers and present practice for lubricating automobiles, as shown at the recent New York exhibitions. 3300 w. Automobile—Feb. 1, 1906. No. 74842.

Motor Cars.

The Horseless Carriage — 1885-1905. Claude Johnson. A review of the first twenty years of the "petrol" movement, or of mechanical road locomotion. Discusses principally automobilism in the United Kingdom. General discussion. 21-000 w. Jour Soc of Arts—Feb. 16, 1906. No. 75268 A.

Motor Skate.

The Motor Skate.—A New Thousand League Boot. Illustrates and describes the invention of M. Constantini, of an automobile skate driven by a small gasoline motor. 700 w. Sci Am—Feb. 10, 1906. No. 74950.

National.

National 6- and 4-Cylinder 1906 Models. Illustrated descriptions of two new touring cars. 2000 w. Automobile—Feb. 1, 1906. No. 74843.

The 3-Cylinder "National" Car. Illustrated description of important improvements made in this British car. 1200 w. Auto Jour—Feb. 10, 1906. No. 75080 A.

Racers.

Final Races at the Ormond Automobile Meet. Illustrations of some of the record-holding racers, with report of their performance. 1700 w. Sci Am—Feb. 10, 1906. No. 74953.

We supply copies of these articles. See page 155.

Shocks.

Types of American Shock Absorbers. Illustrates and describes devices for deducing the effect of shocks to the springs and body of a car when traveling rough roads. 3000 w. Automobile—Feb. 8, 1906. No. 74929.

Six-Cylinder.

Six-Cylinder Cars at the Shows. Illustrates and describes the six-cylinder cars shown at the recent exhibitions in New York. 3500 w. Automobile—Feb. 1, 1906. No. 74841.

Spyker.

The 1906 Spyker Cars. An illustrated article describing the alterations introduced in the latest cars. 1800 w. Auto Jour—Feb. 3, 1906. No. 74981 A.

Tractors.

Petrol-Motor Tractors for Military Use. Illustrates and describes two lately constructed motor tractors, one of 40-brake-h. p. and the other of 25-brake-h. p. 700 w. Engng—Feb. 2, 1906. No. 74995 A.

Truck.

The Four Wheel Drive Truck. Illustrated description of a new model, bevel gear-driven to both front and rear axles, there being no chains employed. 1000 w. Ir Age—Feb. 15, 1906. No. 75002.

COMBUSTION MOTORS.

Balancing.

Balancing of Petrol Engines. Archibald Sharp. Explains the principal phenomena involved in the "balancing" of the engine, in a manner intelligible to the non-technical reader. 1800 w. Autocar—Jan. 27, 1906. Serial. 1st part. No. 74870 A.

Gas Analysis.

Improved Orsat Apparatus for Gas Analysis (Neue Orsat-Apparate für die Technische Gasanalyse). Dr. C. Hahn. The improved absorption apparatus enables the hydrogen, methane, carbon monoxide and dioxide, and heavy hydrocarbons in fuel illuminating, or waste gases, to be quantitatively determined. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 10, 1906. No. 75118 D.

Gas Engines.

Formulas and Constants for Gas Engine Design. Sanford A. Moss. Rules are given for the size of all the more important parts; the formulas are rational whenever possible, and an effort has been made to arrange everything in the most convenient form for a designer's use. 2000 w. Mach, N. Y—Feb., 1906. No. 74798 C.

Gas Engine Construction and Economy. Helon B. Macfarland. Gives tables showing the efficiency and the relation between thermal efficiency of the engine, the heating value of the gas, and the cubic feet of gas used by an engine. 1800 w. Engr, U S A—Feb. 1, 1906. No. 74861 C.

Gas Engines as Applied to Electric Driving. James Atkinson. Abstract of a paper before the Manchester Soc. of the Inst. of Elec. Engrs. Gives particulars of three sets of engines with suction-gas plants, with information concerning methods of governing, and the driving of alternating-current dynamos, etc. Ills. 4000 w. Mech Engr—Feb. 3, 1906. No. 74985 A.

Gas Power.

Gas Engines and Gas Producers (Gasmaschinen und Kraftgaserzenger). Otto Hoffmann. With illustrations of pressure and suction gas plants; also several types of two and four cycle gas engines, giving data of operative costs. 3500 w. Elektrotech u Maschinenbau—Feb. 4, 1906. No. 75145 D.

Gas Engines as Applied to Electric Driving. James Atkinson. Abstract of a paper before the Manchester Soc. of the Inst. of Elec. Engrs. Gives particulars of three sets of engines with suction gas plants showing how economically electric current can be generated when producer gas is used. And gives views of the relative merits and demerits of the various methods of regulating. 3000 w. Elect'n, Lond—Feb. 16, 1906. No. 75277 A.

Gas Producers

Producer Gas and Gas Producers. Charles H. Day. Discusses the methods employed to produce a suitable and sufficiently cheap gas for power purposes. 2500 w. Power—Feb, 1906. No. 74901 C.

Ignition.

The Rankin Kennedy System of Magneto Ignition. Illustrated description of a magneto ignition system for internal combustion engines in which the spark is obtained in the cylinder by means of a high-speed magneto machine working in conjunction with a trembler coil. 700 w. Engng—Feb. 16, 1906. No. 75285 A.

HEATING AND COOLING.

Heat Losses.

Calorimetric Methods of Determining the Loss of Heat from Buildings and Radiators. A. H. Barker. Read before the Inst. of Heat and Vent. Engrs (England). Suggests methods which the writer considers more reliable than most methods in use. 4500 w. Plumb & Dec—Feb. 1, 1906. No. 74980 A.

Refrigeration.

Department Store Refrigeration. Illustrates and describes refrigerating plants in Chicago department stores. 1500 w. Ice & Refrig—Feb., 1906. No. 74848 C.

We supply copies of these articles. See page 155.

Refrigeration with Electric Motive Power. Dr. Alfred Gradenwitz. Illustrated, with description of the arrangement and operation of the apparatus, showing that refrigeration is available wherever electric current can be obtained. 1100 w. Sci Am—Feb. 3, 1906. No. 74812.

The Electrical Driving of Cold Storage and Ice-Making Plants. Sydney F. Walker. Considers the application of electricity to this work, the properties of different refrigerating agents, etc. 5400 w. Elec Rev, N Y—Feb. 17, 1906. No. 75034.

Ventilation.

Centrifugal Ventilating Machines. F. Ernest Brackett. Discusses the method used by some engineers of correlating the size of the fan to the volume of the air, and the scientific basis upon which it rests. 2500 w. Eng. & Min Jour—Feb. 3, 1906. No. 74839.

Plenum Ventilation Systems for School Houses (Ueberdruck-lüftung mit Ventilatoren betrieb in Schulen). Richard Hoffmann. Discussing both warming and ventilating problems, with diagram for computing the loss of heat through windows. 5000 w. 1 plate. Gesundheits-Ingenieur—Jan. 27, 1906. No. 75149 B.

The Ventilation of Theaters (Die Lüftung der Theater). H. Pfützner. A general review of methods of theater ventilation, taking into account the relations of the stage and the auditorium, and the questions of the relative temperatures and heights of the air columns. 8000 w. Gesundheits-Ingenieur—Jan. 20, 1906. No. 75148 B.

Water Heating.

Improved Devices for Heating Water by Steam (Neuere Apparate zur Dampfwarmwasserbereitung). Paul Hoffmann. Illustrating and describing heaters of the counter-current type in which the steam and the water flow in opposite directions. 1800 w. Gesundheits Ingenieure—Feb. 3, 1906. No. 75150 B.

HYDRAULICS.

Centrifugal Pumps.

The Sulzer High Pressure Centrifugal Pumps (Sulzer-Hochdruck-Zentrifugalpumpen). S. Herzog. A general description of the multiple centrifugal pump with guide vanes, as made by Sulzer Brothers, of Winterthur, Switzerland, with curves showing performances and efficiencies at different speeds. Three articles. 7000 w. Elektrotech u Maschinenbau—Jan. 14, 21, 28, 1906. No. 75142 each D.

Niagara.

Niagara Power Schemes. Review of a lecture by Prof. Unwin before the students of the Institution of Mechanical Engineers. An account of the stations already established, and problems which had to be considered, with brief reference to the effect on the Falls. 3700 w. Engng Feb. 16, 1906. No. 75289 A.

Pump Plant.

A Large Rotary Pump Plant. Brief illustrated description of the Pine Island plant for irrigating a Southern rice field; two pumping plants were installed in order to divide the lift. 900 w. Am Mach—Vol 29. No. 4. No. 74823.

Turbine Pump.

Large Turbine Pump for the Montreal Water and Power Company. Illustrated description of a pump designed to deliver 6½ million imperial gallons per twenty-four hours against a head of 30 ft. 1000 w. Engng—Feb. 2, 1906. No. 74996 A.

Water Power.

Adirondack Power. Alton D. Adams. On the immense undeveloped water power available from the Adirondack Mts. 1000 w. Elec Rev, N Y—Feb. 24, 1906. No. 75255.

The Water Power Development of the Chicago Drainage Canal. Illustrated detailed description of works required to develop this power. 5800 w. Eng Rec—Feb. 17, 1906. No. 75055.

MACHINE WORKS AND FOUNDRIES.

Apprentices.

See Industrial Economy.

Balancing.

Balancing at High Speeds. E. R. Douglas. Discusses the importance of accurate balancing in turbine work, and the methods and problems. 2800 w. Am Mach—Vol. 29. No. 8. No. 75234.

Castings.

Handling and Machining Large Engine Frames. B. B. Gaffer. Illustrated description of the various operations from pouring the molds to loading for shipment. 1500 w. Am Mach—Vol. 29. No. 5. No. 74815.

Open-Hearth Steel Castings. W. M. Carr. Illustrates and describes a modern stationary furnace of 20 tons' capacity, and gives some arguments in favor of movable types; also some general rules as to points of construction and volumes. 3000 w. Foundry—Feb, 1906. No. 75204.

Statuary Casting Department of the Gorham Mfg. Co., Providence, R. I. Illustrated description of the work of molding and casting statues. 1500 w. Foundry—Feb, 1906. No. 75205.

Cast Iron.

Heat Treatment of Cast Iron. P. Munnock. Gives diagrams, showing the utility of a diagram from a transverse testing machine, explaining the method of

taking the diagrams. 1000 w. Ir & Coal Trds Rev—Feb. 9, 1906. No. 75222 A.

Core-Boxes.

Multiple Core-Boxes. H. W. Tuttle. Describes the making of these boxes. Ills. 1000 w. Foundry—Feb, 1906. No. 75203.

Cost-Estimates.

The Insulating Cost in the Manufacture of Dynamo-Electric Machinery. H. M. Hobart. An investigation of the cost of the labor and material entering into the insulating of dynamo-electric machinery. 2200 w. Elec Engr, Lond—Feb. 16, 1906. No. 75272 A.

Crossheads.

Making Interchangeable Crossheads, Bodies and Slippers. J. C. Dufresne. Illustrated description. 900 w. Am Mach—Vol. 29. No. 7. No. 75014.

Drills.

Design for Sliding Head for Upright Drill. H. F. Noyes. Illustrates and describes this device and its construction; the novel features are in the power feed and the automatic stop. 800 w. Am Mach—Vol. 29. No. 7. No. 75011.

Drums.

Making Countershaft Drums at the Works of the Landis Tool Company. H. F. Noyes. Illustrated detailed description. 800 w. Am Mach—Vol. 29. No. 8. No. 75235.

Electric Driving.

Motor-Drive and Machine Shop Economy. E. R. Douglas. Reviews the development of motor-driving in machine shops, stating the advantages, and the systems of speed control that have been commercially successful. 4000 w. Elec Rev, N Y—Feb. 10, 1906. No. 74963.

Power Required by Machine Tools, with Special Reference to Individual Motor Drive. G. M. Campbell. Presents deductions from the various motor equipments in a modern shop, giving curves of power and examples of every day practice; also discussion. 5800 w. Pro Engrs' Soc of W Penn—Feb, 1906. No. 75090 D.

Files.

Files and File Testing. Edward G. Herbert. An investigation of files and factors governing their efficiency. 4000 w. Am Mach—Vol. 29. No. 7. No. 75010.

Foundries.

Foundry Blackings and Partings. E. L. Rhead. Discusses in detail the various substances used for blacking the surface of molds. 3500 w. Mech Engr—Jan. 20, 1906. No. 75015 A.

Foundry Practice. William A. Bole. Read before the Pittsburg Found. Assn. Discusses the qualities of pig iron, molten irons, charcoal irons, scrap, etc., the requirements of castings, their composition and related subjects of interest. 5000 w. Ir Age—Feb. 15, 1906. No. 75004.

Foundry Problems. Dr. Richard Moldenke. Address to the Pittsburg Found. Assn. Discusses problems for improving the quality of the castings. 2000 w. Ir Trd Rev—Feb. 15, 1906. No. 75009.

Notes on American Foundry Operation (Betrachtungen über den Amerikanischen Giessereibetrieb). B. Osann. A review of a visit to the United States with especial reference to the operation of the iron and steel foundries of the larger American shops. Two articles. 4000 w. Stahl u Eisen—Jan. 15, Feb. 1, 1906. No. 75137 each D.

Gate Valves.

Some Large Gate Valves. Illustrates and describes the construction of some gate valves of 9 ft. water-way, for the Niagara Power Co. 1200 w. Am Mach—Vol. 29, No. 5. No. 74817.

Lathe.

68-In. Lathe for Turning Crank-Shafts. Illustrated description of a lathe built in Russia, for turning heavy marine-engine crank-shafts for the Newsky Shipbuilding Yard, St. Petersburg. 1000 w. Engng—Feb. 16, 1906. No. 75286 A.

Light Machinery.

Cold Drawn and Rolled Steel in the Manufacture of Light Machinery. Fred W. McArdle. Describes the work of building adding machines, the materials used, etc. Ills. 1400 w. Am Mach—Vol. 29, No. 6. No. 74939.

Melting.

Melting Ratio. John Doyle. Discusses satisfactory melting, not favoring the high melting ratio. 1000 w. Foundry—Feb., 1906. No. 75202.

Milling.

Worm Milling. John Edgar. On methods of milling worms, the shape of cutters, etc. Ills. 1500 w. Am Mach—Vol. 29, No. 6. No. 74938.

Molding.

Molding Tools and Appliances. E. L. Rhead. An illustrated article considering the tools generally used and which are necessary for even simple operations. 2800 w. Mech Engr—Feb. 3, 1906. No. 74983 A.

Organization.

The Organization of an Engineering Works. W. O. Horsnaill. Describes the shop organization, in connection with a previously described organization of the drawing-office, which will conduce to the turning out of work in the cheapest and

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most efficient manner. 1700 w. Engr, Lond—Jan. 26, 1906. No. 74887 A.

Pickling.

Acid Dips and Pickles for Brass Castings. H. J. Hawkins. Explains the uses of several acids in the manufacture of cast brass. 1200 w. Foundry—Feb, 1906. No. 75206.

Pistons.

Manufacturing Steam Pistons. J. M. Menegus. Illustrates and describes tools and fixtures used in making pistons. 1000 w. Am Mach—Vol. 29, No. 7. No. 75012.

Protective Devices.

Improved Protections for Grinding Wheels (Nouveaux Protecteurs pour Meules Artificielles). Henri Mamy. Discussing especially methods for the removal of dust from grinding wheels by the use of exhaust fans and flues. 1000 w. Génie Civil—Feb. 10, 1906. No. 75130 D.

Shears.

A German Electric Bloom Shear. Abstract of an article by A. Schwarze, in *Stahl und Eisen*. Illustrated detailed description of several arrangements. 1500 w. Ir Age—Feb. 15, 1906. No. 75003.

Shops.

The Colburn Machine Tool Company's Shop. Illustrated description of details and partial specifications. 4800 w. Mach, N Y— Feb, 1906. No. 74797 C.

Time Keeping.

Estimating Time on Machine Work. J. H. Van Yorx, Jr. Considers some points that may aid in estimating, suggesting methods applicable to various classes of work. 2500 w. Mach, N Y—Feb., 1906. No. 74799 C.

Valves.

The Dyblie Reversing Valve. Illustrates and describes a reversing valve adapted to open hearth, soaking pit and similar furnace installations. 800 w. Ir Age—Feb. 22, 1906. No. 75228.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys. Prof. A. Humboldt Sexton. The first of a series of articles aiming to give an account of the investigations that have been made and the facts discovered during the last few years, in so far as they are of importance to the maker and user of alloys. 2000 w. Mech Engr—Jan. 27, 1906. Serial. 1st part. No. 74872 A.

Alloy Steels.

Notes on Metals and Their Ferro-Alloys Used in the Manufacture of Alloy Steels. O. J. Steinhart. Abstract of a paper read before the Inst. of Min. & Met. Nickel, chrome, molybdenum, vanadium, tungsten, and titanium, cobalt, uranium, and tantalum are briefly considered. 2800 w. Ir & Coal Trds Rev—Jan. 26, 1906. No. 74882 A.

The Industrial Future of Special Steels. Léon Guillet. A brief review of these steels and their properties. 2400 w. Ir & St Mag—Feb., 1906. No. 75095 D.

The Manipulation of High-Speed Steels. W. J. Todd. Hints for the working of these steels. 1500 w. Mach, N. Y.—Feb., 1906. No. 74802 C.

Bauxite.

Refractory Uses of Bauxite. A. J. Aubrey. Reports some tests made with bauxite bricks and mentions their uses for open-hearth furnaces, the lining of kilns, and lead-refining furnaces. 2200 w. Ir Trd Rev—Feb. 1, 1906. No. 74814.

Brittleness.

The Effect of Nitrogen on Iron and Steel. Abstract of a monograph by Dr. Hjalmar Braune, discussing the effect of minute quantities of nitrogen in producing brittleness in iron and steel. 800 w. R R Gaz—Vol. XL. No. 6. No. 74949.

Bronze.

Manganese-Bronze and Its Manufacture. Edwin S. Sperry. Abstract from an article in the *Brass World*. Gives the history of this alloy, explaining the theory and describing the manufacture. 3000 w. Am Mach—Vol. 29. No. 5. No. 74816.

Nickel Steel.

Nickel Steel and Its Application to Boiler Construction. G. B. Waterhouse. A brief survey of the properties of nickel steel that make them especially adapted for this use. 2000 w. Ir Age—Feb. 8, 1906. No. 74903.

Testing.

Impact Testing. Capt. Riall Sankey. Remarks concerning the various shock or impact tests at present in use, describing more particularly the one-blow method. 4800 w. Engr, Lond—Jan. 26, 1906. No. 74889 A.

Testing-Machine.

600,000-Lb. Vertical Testing-Machine. Illustrated description of a machine of great capacity, built by a Philadelphia firm. 600 w. Engng—Feb. 16, 1906. No. 75284 A.

MEASUREMENT.

Indicator.

The Frahm Speed Indicator. W. C. Martin. Plate and description, with explanation of the action. 1000 w. Trans Inst of Engrs & Shipbuilders in Scotland —Feb., 1906. No. 75210 D.

POWER AND TRANSMISSION.

Bearings.

A Bearing for High-Speed Journals (Ein Lager für Hohe Zapfengeschwindig-

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keiten). F. Niethammer. Illustrating a bearing arranged to be lubricated by oil under pressure as designed for the turbodynamo of the Alioth Company, of Basel, Switzerland. 1000 w. Zeitschr d Ver Deutscher Ing—Feb. 10, 1906. No. 75120 D.

Variation of Pressure in Bearings Due to Eccentric Loading. Gives a diagram devised to show the effects upon bearings of eccentric loading or unsymmetrical supports. 600 w. Am Mach—Vol. 29, No. 8. No. 75236.

Cableway.

A New Design of Aerial Tramway. George K. Davol. Illustrates and describes a wire rope aerial tramway recently installed at the mines of the American Magnesite Co., in Santa Clara County, Cal., which has a length of a little more than half a mile, and a fall between terminals of 650 feet. 4400 w. Jour of Elec—Feb., 1906. No. 75057 C.

Clutches.

The Location and Use of Friction Clutches. W. H. Wakeman. Considers the benefits of friction clutches, presenting points in regard to their proper use. Ills. 3000 w. Am Mfr—Feb. 8, 1906. No. 74922.

Compressed Air.

Compound Air Compression. Lucius I. Wightman. Considers jacket cooling and intercooling, multistage compression, &c. 4200 w. Am Mach—Vol. 29, No. 5. No. 74818.

Derivation of Formulæ for Single and Stage Compression, also Proof of Conditions Governing Best Proportioning and Highest Economy in Stage Compression. Edward F. Schaefer. Shows how the formula for horse-power is developed. 1200 w. Sib Jour of Engng—Jan., 1906. Serial. 1st part. No. 74796 C.

Tests of Small Compressors. Max Kurth. Illustrated descriptions of complete methods used for determining the efficiencies of small air compressors running at high speeds. 2800 w. Mines & Min—Feb., 1906. No. 74935 C.

Cranes.

4-Ton Hydraulic Wharf Crane. Illustrated description of a crane being built for the Port of Antwerp. 500 w. Engng—Feb. 16, 1906. No. 75283 A.

The Electric Travelling Crane. States the advantages of electric cranes, and explains the methods of applying electricity, and the advantages of each. 2000 w. Elec Engr, Lond—Jan. 26, 1906. No. 74875 A.

Gears.

Designing Spiral Gears. F. J. Bostock. Explains a graphical method, without formulas and requiring as little knowledge of trigonometrical ratios as possible. 1700 w. Am Mach—Vol. 29. No. 4. No. 74824.

Some Special Forms of Inside and Outside Gears. Robert Sibley. Notes and formulas in regard to inside and outside gears with movable centers. 700 w. Am Mach—Vol. 29. No. 6. No. 74940.

Speed-Change Gears. A. M. Sosa. Illustrated examples of speed-change gearing, especially those that apply to feeds for machine tools. 1000 w. Am Mach—Vol. 29, No. 7. No. 75013.

Worm Contact. Robert A. Bruce. Calls attention to some of the more obvious omissions that have been overlooked in the experimental investigations of the actions involved in worm-gearing. Ills. 7500 w. Inst of Mech Engrs—Jan. 19, 1906. No. 74885 D.

Transporters.

Transporters in the Outer Harbor at Emden (Verladebrücken im Aussenhafen zu Emden). Illustrated description of two bridges and conveyors for transporting cargo between vessels and railways at Emden, on the North Sea coast of Germany. 1200 w. Zeitschr d Ver Deutscher Ing—Feb. 3, 1906. No. 75109 D.

Unloading.

Ore-Unloading by Machinery. Day Allen Willey. Many illustrations, with description of the new Hulett unloading apparatus recently placed in operation on the Great Lakes for unloading cargoes of ore and coal. 1200 w. Sci Am—Feb. 10, 1906. No. 74952.

STEAM ENGINEERING.

Boilers.

Steam Boiler Efficiencies. John B. C. Kershaw. Gives tests obtained under working conditions showing that gains in evaporative efficiency are possible, and describing devices and new forms of construction. 2000 w. Power—Feb., 1906. No. 74900 C.

Chimneys.

See Civil Engineering, Construction.

Draft.

Chimney Draft and Forced Draft. J. W. Richards. Considers methods of calculating the theoretical total suction of a chimney, illustrating by problems and solutions. 3500 w. Elec-Chem & Met Ind—Feb., 1906. No. 74911 C.

Engines.

Comparison Between Torpedo Boat and Merchant Marine Engines. Dr. Alfred Gradenwitz. An illustrated article comparing size, weight, &c., of engines of equal horse-power. 700 w. Sci Am Sup—Feb. 10, 1906. No. 74954.

Taking Care of an Engine. W. H. Wakeman. Calls attention to details the

care of which will result in satisfactory service. Ills. 2000 w. Power—Feb., 1906. No. 74897 C.

Flow.

The Flow of Steam Through Nozzles. An experimental study, discussing in some detail the results obtained in Mr. Rosenhain's experiments, as given in the Pro. of the Inst. of Civ. Engrs. 4000 w. Engng—Feb. 2, 1906. No. 74993 A.

Governor.

The Williams Governor and Its Design. E. F. Williams. Illustrated description of a governor designed to operate light running, balanced valves at a speed variation of from 2 to 2½ per cent. 2000 w. Engr, U S A—Feb. 1, 1906. No. 74860 C.

Modern Plant.

An Efficient Modern Steam Plant in Flour-Mill Service. William H. Bryan. Reports an investigation made to ascertain the efficiency of a new power plant, and to compare with the results of the old plant, &c. Ills. 5500 w. Jour Assn of Engng Socs—Jan., 1906. No. 75098 C.

Slide Valves.

The Application of Calculating Charts to Slide-Valve Design. William J. Goudie. Gives calculating charts designed by the author, explaining their use. 4500 w. Trans Inst of Engrs & Shipbuilders in Scotland—Dec. 19, 1905. No. 75209 D.

Smoke.

Presidential Address at the Conference on Smoke Abatement. Sir Oliver Lodge. Urging the conversion of coal into gas, and the piping to towns, not allowing the crude combustion of coal. 3400 w. Jour Roy San Inst—Feb., 1906. No. 75088 D.

Smoke Abatement. John B. C. Kershaw. A report on the London smoke abatement conference 3800 w. Cassier's Mag—Feb., 1906. No. 74921 B.

Steam Consumption.

The Steam Consumption of Reciprocating Engines. T. Stevens, and H. M. Hobart. A study of the dependency of the steam consumption on the admission pressure, the effect of the degree of vacuum on the steam consumption and the effect of superheat. 1500 w. Elec Wld —Feb. 17, 1906. No. 75041.

Steam Turbines.

The Economy of Steam Turbines Compared with that of Reciprocating Engines. T. Stevens and H. M. Hobart. A research investigating the operation of the steam turbine under various conditions, and its comparative qualities as related to the reciprocating engine. Also editorial. 2500 w. Elec Wld—Feb. 24, 1906. No. 75267.

The Evolution and Prospects of the Elastic Fluid Turbine. R. M. Neilson. Gives an historical review showing the progress made in utilizing elastic fluids other than air, with suggestions for future improvement. Discussion. 14500 w. Trans Inst of Engrs & Shipbuilders in Scotland—Dec. 19, 1905. No. 75208 D.

The Regulation of Multi-Stage Steam Turbines (Die Regelung Mehrstufige Dampfturbinen). Harry Jansson. Describing a method of speed regulation by cutting out successive stages of the expansion, in steam turbines of the Parsons type. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 10, 1906. No. 75119 D.

Why the Steam Turbine Is Not More Efficient. R. M. Neilson. Discusses the losses in turbines, and how to reduce them. 1200 w. Power—Feb., 1906. No. 74898 C.

See Marine and Naval Engineering.

Stoking.

Mechanical Firing (Mechanische Feuerungen). Hr. Nies. Describing mechanical stokers in use in Germany, with especial reference to the production of a minimum amount of smoke. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 3, 1906. No. 75110 D.

Superheating.

Superheated Steam. Michael Longridge. A lecture at Bradford Tech. School. Gives an explanation of why superheated steam improves the economy of the steam-engine, and the principles on which a superheating plant should be designed. 10000 w. Engng—Feb. 2, 1906. No. 74873 A.

Thermodynamics.

Contributions to the Dynamics of Elastic Fluids (Beiträge zur Dynamik der Elastischen Flüssigkeiten). Dr. A. Fliegner. An examination of the modifications in the flow of steam and gases from nozzles, due to the elasticity of the fluid. Two articles. 3500 w. Schweiz Bauzeitung—Jan. 20, 27, 1906. No. 75124 each B.

MISCELLANY.

Aeronautics.

A Proposed Solution of the Problem of Flight. Franz Pabisch. Translated from *Stein der Weisen.* Illustrated discussion of several flying machines, and their ability to satisfy necessary conditions. 1000 w. Sci Am Sup—Feb. 10, 1906. No. 74956.

The Alighting of Aeroplanes (Sur l'Atterrissage des Aeroplanes). M. Bouquet de la Grye. Describing the application of a horizontal plane above the supporting surfaces, to enable the machine to maintain its equilibrium during the descent. 800 w. Comptes Rendus—Jan. 15, 1906. No. 75115 D.

We supply copies of these articles. See page 155.

The Helicoptere: Santos-Dumont's Latest Flying Machine. L. Ramakers. Illustrated description of a machine in course of construction. 1300 w. Sci Am —Feb. 10, 1906. No. 74951.

Analysis.

A Graphic Method of Harmonic Analysis. J. Harrison. Describes a graphical process for the harmonic analysis of cyclical functions, explaining the method. Diagrams. 1200 w. Engng—Feb. 16, 1906. No. 75282 A.

Card Index.

The Application of Card Index Systems to a Motive Power Office. J. H. Wynne. Gives sample cards used, explaining their convenience. 1200 w. Ry Mas Mech—Feb., 1906. No. 74826.

History.

The Changes of One Lifetime in the Machine Shop. Egbert P. Watson. An account of the experience of the author in connection with the advance in materials, shop methods, and machine tools during the past fifty years. 3500 w. Engineering Magazine—March, 1906. No. 75167 B.

Laundry Machinery.

The Technology of Laundry Machinery (Die Technischen Hülfsmittel der Mechanischen Wäschereinigung). G. Rohn. With numerous illustrations of machines for the various laundry operations, and a bibliography of works upon the subject. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 3, 10, 1906. No. 75108 each D.

Oxygen Flasks.

The Explosion of Oxygen Flasks (Ueber Sauerstoffflaschen-Explosionen). R. Nowichi. An account of the bursting of cylinders of compressed oxygen, showing such occurrences to be due to the presence of hydrocarbons, or to defective valve construction. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 20, 1906. No. 75134 D.

MINING AND METALLURGY

COAL AND COKE.

Breaker.

The Truesdale Breaker. Illustrated description of a new breaker and washery, designed to handle an output of four thousand tons per day. 4000 w. Mines & Min—Feb, 1906. No. 74930 C.

Briquettes.

Some Notes on Fuel Briquetting in America. Clarence M. Barber. Considers the use of briquettes in Europe, their manufacture and the materials used, and the introduction of the industry in America. 3000 w. Jour Assn of Engng Socs—Jan, 1906. No. 75099 C.

California.

California's New Coal Fields. Clarence E. Edwords. Information concerning the bituminous deposits recently discovered and their value. 1700 w. Min Wld—Feb. 17, 1906. No. 75050.

Coal Storage.

Coal-Storage Bunker and Band Conveyor for the Bargold and New Tredegar Collieries. Illustrates and describes the coal-bunker and steel-structural work at the Bargold colliery; and the improved band-conveyor recently installed at the New Tredegar colliery in South Wales. 2000 w. Engng—Jan. 26, 1906. No. 74893 A.

Coke.

Caking Fine Coal for Coking. Alfred Ernst. Considers the advantages of stamping and compacting at by-product ovens. 3000 w. Ir Age—Feb. 22, 1906. No. 75227.

Coke Oven.

Modern Features of the United Otto Coke Oven. Illustrated description extracted from a recently issued pamphlet. 2000 w. Ir Age—Feb. 22, 1906. No. 75226.

Coke Plant.

The Colonial Coke Co.'s Plant. Illustrated detailed description of a plant in the region commonly known as the Lower Connellsville district. The mine turns its output into coke. 1700 w. Eng & Min Jour—Feb. 3, 1906. Serial. 1st part. No. 74838.

Firedamp.

Safety Lamp Gauzes and Flame Tests for Firedamp. J. Ashworth. Reports extensive experiments and tests made on a variety of lamps in the present number. Ills. 2000 w. Ir & Coal Trds Rev—Jan. 26, 1906. Serial. 1st part. No. 74884 A.

Pittsburg.

Banning No. 2 Mine. Illustrated description of this coal mine near Pittsburgh, especially its system of endless rope haulage. 1400 w. Eng & Min Jour—Feb. 17, 1906. No. 75040.

Review.

Coal Mining in 1905. E. W. Parker.

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Gives details of production from the various coal districts of the United States, showing great activity. 2400 w. Min. Wld—Jan. 27, 1906. No. 74776.

COPPER.

Arizona.

Arizona. An illustrated article reporting the different districts. Gains of thirty-six million pounds of copper are given over the previous year. 6500 w. Min Wld. Jan. 27, 1906. No. 74784.

Australia.

The Wallaroo and Moonta Mines. L. Hancock. Information concerning these copper mines of South Australia, and their operation. 700 w. Eng & Min Jour —Feb. 10, 1906. No. 74942.

Copper Trade.

See Industrial Economy.

Refinery Plant.

Copper Refinery Plant for Martin's Direct Rolling Process. H. J. Martin. Plan and description with summary of advantages. 2500 w. Foundry—Feb. 1906. No. 75207.

Volumetric Method.

A New Volumetric Method for Copper and the Ores of Copper. Alfred Adair. The method is based on the precipitation of sub-sulphocyanide of copper from its solutions under conditions which have been found to give constant results. 2000 w. Jour Chem, Met & Min Soc of S. Africa—Dec., 1905. No. 75079 E.

Works.

The Nichols Copper Works. O. Perfahl. Translated from *Zeit. f. Berg-, Hütten u. Salinenwesen.* Brief description of extensive works at Laurel Hill, Long Island, N. Y., where crude copper, containing precious metals, is refined by electrolysis on the series system. 800 w. Eng & Min Jour—Feb. 17, 1906. No. 75036.

GOLD AND SILVER.

Assay Values.

Computation of Assay Values. William Crosley. Read before the Inst. of Min. & Met. Discusses the accuracy of methods of computing values for deposits varying greatly in shape and richness. 2500 w. Mines & Min—Feb., 1906. No. 74936 C.

Australia.

Gold Mining in Western Australia. John Plummer. Brief report with discussion of the cause of a decline in production during the past two years. 800 w. Min Wld—Jan. 27, 1906. No. 74781.

Cyanide Process.

Gold Molecules in Solution. G. T. Beilby. A study of the problems of solution as shown in the practice of the cyanide process of gold extraction. 2500 w. Sci Am Sup—Feb. 17, 1906. No. 75030.

Desert-Mining.

A Southern California Desert Mining. Kirby Thomas. An illustrated account of the exploring and opening up of these desert regions. 2500 w. Min Wld—Feb. 3, 1906. No. 74844.

Dredging.

A New Gold Dredge. George L. Hurst. Illustrated description of a new dredge recently built at El Dorado, on the American River. Dredging is possible to a total depth of 50 ft. 1500 w. Min & Sci Pr—Jan. 27, 1906. No. 74847.

The Prospecting and Valuing of Dredging Ground. Norman C. Stines. Describes the prospecting of gravel deposits by means of the Keystone drill, to test their fitness for dredging purposes. Ills. 2000 w. Min & Sci Pr—Feb. 3, 1906. Serial. 1st part. No. 74967.

Filter-Press.

Filter-Press Practice in Western Australia. A. B. Wallace. Illustrates and describes this method of treating gold-bearing slimes. 1200 w. Min & Sci Pr—Feb. 3, 1906. No. 74968.

Gold Mines.

Gold Mines of the World. Abstracts and extracts from J. H. Curle's book, by Prof. Arthur Lakes. An illustrated review of the principal gold mines and mining regions. 6000 w. Mines & Min—Feb, 1906. No. 74932 C.

Idaho.

The Bullwhacker Mine, near Hailey, Idaho. A. Lakes. Illustrates and describes the geology of this mine and its deposits of lead-silver ore. 1200 w. Min Rept—Feb 15, 1906. No. 75046.

Ore Deposits.

The Ore Deposits of the Ontario Mineral Belt. Walter P. Jenney. Describes the geology of this vein in Utah, and the deposits of silver-lead ore, with other minerals. 4000 w. Min & Sci Pr—Feb. 17, 1906. No. 75254.

Production.

Gold and Silver Production of the World. Charles C. Schnatterbeck. A review of the past year showing a phenomenal growth in the gold output, and giving information concerning the United States, and foreign countries. 3500 w. Min Wld—Jan. 27, 1906. No. 74775.

Queensland.

Black Ridge, Clermont. Lionel C. Ball. Recent notes given as a supplementary report to an earlier article. Deals with the geology, mining and milling, claims, &c. Ills. 8500 w. Queens Gov Min Jour —Dec. 15, 1905. Serial. 1st part. No. 74867 B.

We supply copies of these articles. See page 155.

Reduction.

Ore Reduction at the Sons of Gualia Mine. Robert Allen. Describes the treatment of this gold ore of Australia. The ore is a chloritic schist, with lenses of quartz, calcite and gypsum showing occasionally. It is extremely simple to treat being recovered mainly by battery treatment, followed by cyanide treatment ot the sands, and roasting and cyanide treatment of the concentrates. Ills. 4000 w. Min Jour—Feb. 17, 1906. No. 75279 A.

Sampling.

The sampling of Base Bullion. John W. Root. Read before the W. Assn. of Tech. Chem. & Met. Briefly considers the methods in use, and those formerly employed. 1800 w. Min Rept—Feb. 8, 1905. No. 74964.

Silver.

Early Silver Production in Mexico and Its Fluctuations. F. J. H. Merrill. Information concerning the production and its variations. 900 w. Eng & Min Jour—Feb. 24, 1906. No. 75258.

South Dakota.

The Early History of Black Hills, South Dakota. W. H. Storms. Begins an interesting review of this important gold-mining district. 1800 w. Min Wld—Feb. 17, 1906. Serial. 1st part. No. 75048.

Sulphides.

Cerro Gordo. C. H. Laidlaw. Gives history and illustrated description of this California mine. The metals are usually combinations of sulphides and their oxides, carrying gold, silver and copper. 2500 w. Min Rept—Feb. 15, 1906. No. 75045.

Tailings.

Tailing Disposal of Gold Dredges. J. P. Hutchins. Reviews the history of tailing disposal and the methods that have been tried to restore worked out land to its original condition. Ills. 3800 w. Eng & Min Jour—Feb. 3, 1906. No. 74836.

Transvaal.

Van Ryn Gold Mines Estates, Limited. Address of F. A. Gillam at the annual meeting, reviewing the conditions of these mines in South Africa. Ills. 2700 w. Min. Jour—Feb. 3, 1906. No. 74991A.

IRON AND STEEL.

Alloy Steels.

See Mechanical Engineering, materials.

Blast Furnaces.

The Removal of a Salamander from a Blast Furnace. John J. Smith. An illustrated article. Describes the construction of the furnace, the formation of the salamander, and the operations necessary in removing; also the extent of injury to the furnace. 5300 w. Am Mach—Vol. 29. No. 8. No. 75233.

Blowholes.

The Formation of Blowholes in Steel Ingots (Ueber die Bildung von Hohlräumen in Stahlblocken). J. Riemer. A discussion of the causes of blowholes and piping in steel ingots, and the defects which follow in forgings and other products. 3000 w. Stahl u Eisen—Feb. 15, 1906. No. 75138 D.

Carbon Determination.

The Determination of Carbon in Ferrochrome and the Eimer Carbon Crucible. C. Offerhaus. The writer compares some direct methods with each other and with Wochler's chlorine method, and gives a short account of his determinations. The Eimer crucible is illustrated and described. 1600 w. Elec Chem Met Ind—Feb., 1906. No. 74912 C.

Cast Iron.

See Mechanical Engineering, Machine Works and Foundries.

Mesaba.

The Western Mesaba Iron Range. Dwight E. Woodbridge. Map and information concerning the mineral wealth of township 56, range 24. 1500 w. Ir Age—Feb. 1, 1906. No. 74788.

Rail Mill.

New Rail Mill of Dominion Iron and Steel Company, Limited, Sydney, Cape Breton. An illustrated description of a modern installation. 2500 w. Can Engr—Feb, 1906. No. 74840.

Rolling Mills.

New Types of Rolling Mill Gearing. Abstract of a paper by Director Ortmann before a meeting of the Assn. of Ironmasters in South-West Germany and Luxemburg. Illustrates and describes types of gearing, and discusses the cost of motive power. 2500 w. Ir & Coal Trds Rev—Feb. 9, 1906. No. 75223 A.

Some Notes on Modern German Rolling Mills. Illustrates and describes types of modern mills used in Germany and their working and arrangement. 3000 w. Ir & Coal Trds Rev—Jan. 26, 1906. Serial. 1st part. No. 74881A.

The Electric Driving of Rolling-Mill Trains (Elektrischer Antrieb von Reversierwalzenstrassen). F. Weideneder. A comparison of the driving of rolling mills by electric motors with the use of steam engines, using the exhaust steam to operate low-pressure steam turbines. 1800 w. Stahl u Eisen—Feb. 1, 1906. No. 75135 D.

Russia.

A New Iron works in Russia (Ein Neues Russisches Hochofenwerk). Ferd. Heck. A review, with tables and dia-

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grams, of the iron production of Russia, with especial reference to the development of the Tscherdinsk district, in the Government of Perm, between the Unja and Perwokamennoi rivers. 3000 w. Stahl u Eisen——Feb. 15, 1906. No. 75-139 D.

Talbot Process.

The Talbot Continuous Steel Process and its Benefits in Steel-making. G. A. Wilson. Describes the working of this process at the Cargo Fleet works, of Middlesbrough. 2500 w. Ir & Coal Trds Rev—Feb. 16, 1906. No. 75292 A.

MINING.

Alaska.

Alaska. Alfred H. Brooks. Presented at the El Paso meeting of the Am. Min. Cong. The mineral production of the past year shows a remarkable increase over 1904. Ills. 3000 w. Min. Wld—Jan. 27, 1906. No. 74783.

Blasting.

Arrangement for Electric Spitting of Fuses in Shaft Blasting. J. A. Clay. Illustrates and describes an arrangement for igniting the fuses by electricity, to secure greater safety in shaft-sinking. 600 w. Min Rept—Feb. 15, 1906. No. 75047.

Colorado.

Colorado. Kirby Thomas. Reports increased production in all districts with gratifying prospects for 1906. Ills. 10000 w. Min Wld—Jan. 27, 1906. No. 74785.

Concentration.

Mill Experiences. R. D. O. Johnson. An illustrated study of the problem of diminishing the excessive wear on all the parts of a concentrating mill. 1700 w. Eng & Min Jour—Feb. 17, 1906. No. 75038.

The Acme Combined Concentrating Table. L. H. L. Huddart. Illustrated description of a table intended for the treatment of metalliferous slimes, with report of a trial. 1500 w. Min Rept—Feb. 1, 1906. No. 74833.

Drainage.

Mine Drainage at the extreme acidity of the waters and the troubles due to this cause, illustrating and describing pumps used. 2500 w. Min & Sci Pr—Feb. 10, 1906. No. 75043.

Filling.

The Hydraulic Filling of a Coal Seam at Lens, Pas de Calais, France. Lionel E. Hill and Malcolm Burr. Read before the Inst. of Min. & Met. An illustrated description of the process as adapted to the collieries at Lens. 3500 w. Ir & Coal Trds Rev—Feb. 16, 1906. No. 75291 A.

Haulage.

The Application of the Mono Rails in Underground Tramming at the Langlaagte Deep. Wager Bradford. A brief description, with illustrations, of a successful installation of a mono rail system of motor traction, suspended from the roof. 5000 w. Jour S African Ass'n of Engrs—Dec., 1905. No. 74866 F.

Lighting.

Electric Lighting in Subterranean Workings (Elektrische Beleuchtung an Füllörtern und in Strecken unter Tage). E. Anders. A general description of underground electric lighting appliances in accordance with the official mining regulations of Germany. 4000 w. Glückauf—Feb. 3, 1906. No. 75133 B.

Manganese.

The Demand for Manganese Ores. W. Venator. Translated from *Stahl und Eisen*. Reviews the growing importance of these ores and the industry of mining them, the difficulties, and related subjects of interest. 2800 w. Min Jour—Feb. 10, 1906. Serial. 1st part. No. 75-083 A.

Methods.

Mining Methods. W. H. Storms. Specially referring to mining practice in California. 1200 w. Min & Sci Pr—Feb. 10, 1906. Serial. 1st part. No. 75044.

Mine Telephones.

Telephone Lines in Coal Mines. C. M. Means. Some suggestions for the construction of these underground lines. 1200 w. Eng & Min Jour—Feb. 24, 1906. No. 75256.

Mining Law.

Amendments to Federal Mining Law. R. S. Morrison. Read before the Min. Cong. at El Paso. Discusses some of the points in which the present law is unsatisfactory. 1500 w. Mines & Min—Feb, 1906. No. 74931 C.

The New Queensland Mining Bill. Gives an outline of the bill before the Legislative Assembly, which aims to remedy certain defects and supply shortcomings in the present Mining Act. 7500 w. Queens Gov Min Jour—Dec. 15, 1905. No. 74868 B.

The U. S. Supreme Court and the U. S. Mining Law. R. W. Raymond. General remarks, with a notice of the "Stemwinder" and "Bunker Hill" cases. 2000 w. Eng & Min Jour—Feb. 10, 1906. No. 74941.

Montana.

Montana. Reports of prosperity of metal mining enterprises throughout the state. 11000 w. Ills. Min Wld—Jan. 27, 1906. No. 74786.

Motive Power.

Motive Power in Mines. C. H. Caruthers. Briefly refers to the use of animals, and rope haulage in mines, and considers haulage by steam, compressed air and

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electric locomotives. Ills. 2000 w. R R Gaz—Vol. XL. No. 5. No. 74822

Operation.

Electricity vs. Compressed Air for Mine Operation. Edward F. Schaefer. Discusses the advantages of each but considers compressed air far superior as a driving fluid. 2000 w. Sib Jour of Engng—Feb., 1906. No. 75271 C.

Ore Deposits.

Block-Faulting, and Its Relation to Ore Deposition. Walter P. Jenney. An explanation of this singular type of fault-structure and the causes, and the ore deposits in association. 3200 w. Min & Sci Pr—Jan. 27, 1906. No. 74845.

Ore Dressing.

Ore Dressing by Flotation. An account of two recent papers before the Faraday Society. One by James Swinburne and Dr. G. Rudorf, and the other by Prof. A. K. Huntington. Discusses the successful application of this process to the treatment of tailings, its theory, &c. 4000 w. Elec. Chem & Met Ind—Feb., 1906. No. 74909 C.

Ore Handling.

Underground Mechanical Transport in the Witwatersrand. An illustrated article describing methods of dealing with particular cases, and explaining the difficulties in the way of a complete solution. 2500 w. Engr., Lond—Feb. 2, 1906 No. 74998 A.

Ore Treatment.

Successful Treatment of Refractory Ores. Eric Hedburg. Explains the depreciation in value of ores containing zinc, iron, copper and nickel, the difficulty in separating, and the final discovery of a means of successfully treating them so as to recover all values. Ills. 1800 w. Min Wld—Feb. 10, 1906. No. 74965.

Philippines.

Mining in the Philippines. Oscar Halvorsen Reinholt. An illustrated article reporting the present condition of the mining industry. Coal, gold and ores of iron and copper are the most important products. 1500 w. Min Wld—Jan. 27, 1906. No. 74782.

Pneumatic Tools.

Air Hammer Rock Drills in Mining. Edward A. Rix. Read at convention of Cal. Miners' Assn. Gives the history of the introduction, and information in regard to its practical application and advantages. 6000 w. Compressed Air—Jan. 1906. No. 74793.

Production.

The Mineral and Metal Production of the United States in 1905. General remarks with review of both non-metallic and metallic products. Table. 3000 w. Min Wld—Jan. 27, 1906. No. 74774.

Rare Minerals.

Rare Minerals in 1905. Charles C. Schnatterbeck. Gives information concerning tungsten, molybdenum, vanadium, uranium, rutile, monazite, gadolinite, zirconia, tantalite, columbite, osmium, and lithium minerals. 2500 w. Min Wld—Jan. 27, 1906. No. 74779.

Respiration Apparatus.

Respiration Apparatus for Colliery Rescue Work. Profs. M. Bamberger, and F. Böck. Abridged translation from an article in *Glückauf*. Remarks on types of apparatus tried and their defects, with illustrated description of improved apparatus constructed by the authors. 3000 w. Col Guard—Feb. 2, 1906. Serial. 1st part. No. 74992 A.

Separation.

The Separation of Iron from Zinc by Ammonia. Kurt Pietrusky. Gives report of experimental investigations, showing that satisfactory results can only be obtained when there is a large excess of ammonia in the solution. 1500 w. Min & Sci Pr—Feb. 3, 1906. No. 74969.

Shafts.

Gallows Frames for shafts. R. D. O. Johnson. Illustrates and describes a guyed design erected by the writer, and also a proposed design of even greater economy in material. 500 w. Eng & Min Jour—Feb. 24, 1906. No. 75257.

Shaft Sinking.

Modern Methods in Shaft Sinking. James Tonge. Considers improvements for handling buckets, sinking with drums, coffering, and the freezing process. Ills. 2500 w. Mines & Min—Feb., 1906. Serial. 1st part. No. 74934 C.

Smelting.

Smelting Zinc Retort Residues. E. M. Johnson. Abstract of a paper in the *Western Chemist & Metallurgist*. A report of experimental work carried out in Kansas. 800 w. Eng & Min Jour—Feb. 17, 1906. No. 75037.

The Smelting Works of British Columbia. Notes on the changes and improvements made at the various smelters during the year 1905. Ills. 3000 w. B. C. Min Rec—Dec., 1905. Serial. 1st part. No. 74790 B.

Steam Shovel.

The Allis-Chalmers Steam Shovel. W. N. Tanner. Illustrates and describes a type found useful in mining operations. 1000 w. Eng & Min Jour—Feb. 3, 1906. No. 74837.

Surveying.

Anderson's Method for Passing a Survey Line Down a shaft. Describes the method, giving diagrams. 500 w. Min & Sci Pr—Feb. 3, 1906. No. 74966.

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Timbering.

Systematic Timbering at Emley Moor Collieres. H. Baddiley. Illustrates and describes an improved system of timbering with the view of diminishing accidents from falls of roof and sides. 1000 w. Eng & Min Jour—Feb. 17, 1906. No. 75039.

Transvaal.

Transvaal Mining in 1905. Ralph Stokes. An illustrated historical review of the mines and minerals of this district. 5000 w. Min Wld.—Jan. 27, 1906. No. 74780.

Valuation.

The Valuation of Mineral Properties. T. A. O'Donahue. A discussion of the conditions which differ from the valuation of other properties, giving formula deduced to comply with these conditions. 2500 w. Col Guard—Feb. 9, 1906. No. 75078 A.

Ventilation.

Mechanical Mine Ventilation. J. R. Robinson. Read before the Coal Min. Inst. of America. A comparison of various types of fans, the Guibal, Screw Propeller, "Sirocco," Capell, and Robinson. 4000 w. Mines & Min—Feb., 1906. No. 74-933 C.

MISCELLANY.

Antimony.

The West Gore Antimony Deposits. Alex. McNeil. Information concerning this mine in Nova Scotia, its history and development. The deposits are antimony-gold ore. 1500 w. Can Min Rev—Feb. 1906. No. 75225 B.

Coal-Dust Firing.

Coal-Dust Firing of Reverberatory Matt Furnaces. B. Severin. Sörensen. Notes on some experiments made at Murray, Utah, which gave results considered satisfactory. Ills. 1500 w. Eng & Min Jour—Feb. 10, 1906. No. 74944.

Lead.

Methods for the Fire Assay of Lead. Oscar J. Frost. From *Jour. W. Assn. of Tech. Chem. Met.* Describes an operation applicable to a comparatively long fusion with gradually rising temperature. 3000 w. Min Wld—Feb. 17, 1906. No. 75051.

Metallography.

Cooling Curves of Metallic Solutions. Thomas T. Read. Considers the causes of points of inflection in a cooling curve. 1000 w. Ir & St Mag—Feb., 1906. No. 75096 D.

Oil.

The California Oil Fields and Oil Fuel for Locomotives. D. A. Willey. An illustrated account of the development of this field, and the substitution of oil for solid fuel on locomotives, with results. 1200 w. Ry Age—Feb. 23, 1906. No. 75-250.

Quicksilver.

California Quicksilver Industry. Clarence E. Edwords. Historical review of the development and production. Ills. 1600 w. Min Wld—Feb. 24, 1906. No. 75253.

The Mercury Deposits of Mexico. F. J. H. Merrill. Information concerning these deposits, their development and value. 2000 w. Min Wld—Feb. 17, 1906. No. 75049.

Tin.

The Tin Industry in 1905. A review of production and prices, and matters of interest relating to this industry. 2000 w. Min Wld—Jan. 27, 1906. No. 74778.

Zinc.

The Palmerton Works of the New Jersey Zinc Company. O. Pufahl. Translated from *Zeit. f. Berg-, Hutten- und Salinenwesen.* Brief description of the oxide works, spiegeleisen blast furnace, spelter works, lithopone works, and sulphuric acid works. 1200 w. Eng & Min Jour—Feb. 10, 1906. No. 74943.

Zinc Mining in 1905. A review of the progress made towards utilizing the zinc resources of British Columbia. Ills. 1700 w. B C Min Rec—Dec., 1905. No. 74-789 B.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Baggage.

Baggage Service in the United States. E. Giese and Blum, in *Zeitung des Vereins.* An explanation of the system in use in America for forwarding baggage. 7700 w. Bul. Int Ry Cong—Jan., 1906. No. 75220 E.

Car Movements.

Beecham Car Transcribing System. Describes the system of car records used on the C., M., & St. P. Ry., and recently adopted by other roads. Its principal advantage is the ease with which information may be obtained concerning any car. 3500 w. R R Gaz—Vol. XL. No. 5. No. 74821.

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Fares.

Required Reduction of Passenger Fares in Ohio. Extracts from a document prepared by James McCrea to show why passenger fares should not be arbitrarily reduced to two cents a mile in the State of Ohio. 4500 w. R R Gaz. Vol XL. No. 7. No. 75023.

Fast Express.

The Cote d'Azur Rapide. An illustrated account of the first-class passenger express which runs between Paris and the Mediterranean in half a day. 1000 w. Engr., Lond—Feb. 16, 1906. No. 75281 A.

Freight.

In Relation to the Transportation Problem. W. M. Prall. Principally a discussion of freight transportation and its problems. General discussion follows. 9000 w. Pro Ry Club of Pittsburgh—Nov., 1905. No. 75097 C.

Some Ideas in Handling and Tracing High Class Freight. W. B. Harrison. Paper and discussion aiming to simplify the tracing of delayed freight. 3500 w. Pro Iowa Ry Club—Dec. 8, 1905. No. 74795 C.

Italy.

The Government Railroad Monopoly in Italy. The first of a series of articles discussing this subject. 1200 w. R R Gaz —Vol. XL. No. 8. No. 75241.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

New W. A. B. Equipment. The first of a series of illustrated articles which will describe the Westinghouse new air brake equipment for all classes of engines and cars now in use. 1700 w. Ry & Loc Engng—Feb., 1906. Serial. 1st part. No. 74857 C.

Card Index.

The Application of Card Index Systems to a Motive Power Office. J. H. Wynne. Explains the advantages of the card system for railway office records. Also discussion. 6400 w. Pro W Ry Club—Jan. 16, 1906. No. 75224 C.

Cars.

High-Capacity Wagons for Belgium Railways. Illustrates and describes a 35-ton hopper ore-wagon, and a 40-ton wagon for transport of rails, shown at the Liége exhibition. 500 w. Engng—Jan. 26, 1906. No. 74894 A.

New Bogie Transport Cars. Brief illustrated description of cars recently constructed for the transport of steam plowing engines, or similar machines. 300 w. Sci Am Sup—Feb. 17, 1906. No. 75027.

Second-Class Carriage for the International Express Service. Illustrated description of a car designed to seat a larger number of passengers than usual, without increasing the weight of the vehicle. 300 w. Engng—Feb. 9, 1906. No. 75072 A.

The American Palace Car "Columbia." Illustrates and describes the operating mechanism of a combination parlor car and sleeping car. The berths are stored beneath the floor. 800 w. Ry Mas Mech —Feb, 1906. No. 74827.

Thirty-five Ton Steel Gondola Cars for the Natal Government Railways. Brief illustrated description of high-sided gondolas for coal traffic. 300 w. Ry Age—Feb. 2, 1906. No. 74835.

Draft Gear.

Functions of a Good Draft Gear. A. Stucki. Considers the functions in detail, and urges simplicity of construction. 2500 w. R R Gaz—Vol. XL. No. 8. No. 75237.

Electric Locomotive.

Operation of Electric Locomotive During a Snowstorm. An illustrated account of a very interesting test made of one of the N. Y. C. electric locomotives, near Schenectady, N. Y., during a severe snowstorm. 1200 w. R R Gaz—Vol. XL. No. 7. No. 75022.

Locomotive Tests.

Record of the Pennsylvania Locomotive Tests. Editorial review of the final record of the tests made at the Louisiana Purchase Exposition, giving the summary of conclusions. 2000 w. R R Gaz—Vol. XL. No. 6. No. 74946.

The Tests of Locomotives at the St. Louis Exhibition, 1904. Gives some of the special features of these tests, for purposes of comparison, with general information of interest. Also editorial. 6000 w. Eng News—Feb. 15, 1906. No. 75017.

Locomotives.

Atlantic Type Locomotives in Germany. Charles S. Lake. Illustrates types in use, and gives information of interest concerning them. 1400 w. Mech Engr—Feb. 3, 1906. No. 74984 A.

Compound Express Locomotive, G. N. R. Particulars and engravings of this engine, with 2-page supplement. 600 w. Engr., Lond—Jan. 26, 1906. No. 74891 A.

Decapod Locomotive for Mountain Grades on the Argentine Great Western Railway. Illustrated description of an engine designed to meet special conditions, and to operate on stretches of track where the rails are only of moderate weight. 700 w. Ry Age—Feb. 9, 1906. No. 74959.

Delaware & Hudson Locomotives with Young Valves and Gear. Illustrates and describes locomotives (4-6-0) intended for fast-freight service. 500 w. R R Gaz—Vol XL. No. 5. No. 74819.

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De Pambour on Locomotive Engines. Concerning a valuable book published 70 years ago, and an account of how his information was obtained. 4000 w. Engr., Lond—Feb. 9, 1906. No. 75065 A.

Four - Cylinder Compound Locomotive for the Paris-Orleans Railway. Illustrations and dimensions. 400 w. Engng—Feb. 2, 1906. No. 74994 A.

French Compounds on the Great Western Railway. Charles Rous-Marten. A report of the performance of the two new locomotives of the du Bousquet-de Glehn "Atlantic" design, intended for the heaviest and fastest express duty. 4800 w. Engr., Lond—Feb. 2, 1906. No. 74997 A.

Heavy Banking Locomotive, Belgian State Railways. Illustrates and describes a very powerful four-cylinder duplex locomotive, closely imitating the Mallet system, built to assist trains up inclines. 1000 w. Engr., Lond—Feb. 2, 1906. No. 74999 A.

Light Locomotives and Small Trains (Leichte Lokomotiven und Kleinzüge). Hermann von Littrow. Illustrating several designs of small locomotives for special and local service on branches of the Austrian State Railways. 2000 w. Glasers Annalen—Feb. 15, 1906. No. 75140 D.

Links in the History of the Locomotive. Information concerning "The Novelty" engine, with illustrations. Also describes the "William the Fourth" locomotive. 2500 w. Engr., Lond—Jan. 26, 1906. No. 74888 A.

Locomotives with Flexible Wheel Base (Kurvenbewegliche Lokomotiven). E. Metzeltin. Illustrating and describing a 100-ton compound locomotive of the Mallet-Rimrott type for the Northern Railway of France. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 3, 1906. No. 75107 D.

Monon Passenger 4-6-2. Illustrated description of a new Pacific type passenger engine. 800 w. Ry & Loc Engng—Feb., 1906. No. 74858 C.

Powerful Six - Coupled Locomotives. Charles S. Lake. Illustration, with description of a 6-wheel coupled bogie, or 4-6-0 type of locomotive recently introduced on the Great Southern and Western Railway (Ireland). 800 w. Mech Engr—Feb. 10, 1906. No. 75082 A.

Tank Locomotives for the New South Wales Government Railways. Illustrated description of a six-coupled double-bogie tank engine specially designed for heavy suburban passenger service. 400 w. Engng—Feb. 14, 1906. No. 75290 A.

Motor Cars.

Rail Motor Carriage. A. F. Sinclair. Illustrated description of Cochran's steam motor as used on the Great North of Scotland railway. 700 w. Ry & Loc Engng—Feb., 1906. No. 74856 C.

The Strang Gasolene-Electric Rail Motor Car. Illustrated description of an experimental car now on trial. 800 w. R R Gaz—Vol. XL. No. 8. No. 75242.

Superheater.

Vaughan-Horsey Superheater. Illustrates and describes a new type of superheater being tested by the Canadian Pacific Railway. 1000 w. Am Engr & R R Jour—Feb., 1906. No. 74850 C.

Tractive Power.

Tests on the Tractive Power of Locomotives (Untersuchungen über die Zugkraft von Lokomotiven). Dr. Rudolf Sanzin. A comparison of drawbar tests at high speeds upon various European and American lines, plotting the results in curves. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 27, 1906. No. 75105 D.

Train Lighting.

Appendices to the Report No. 2 on the Question of Lighting, Heating and Ventilation of Trains (Subject IX for Discussion at the Seventh Session of the Railway Congress). Cajetan Banovits. The report appeared in this publication in April, 1905. 24 tables and figs. 235 pages. Bul Int Ry Cong—Jan., 1906. No. 75221 E.

The Leitner-Lucas System of Train-Lighting. An illustrated description of apparatus for the electric lighting of trains, which has recently been tested on the Great Western Railway, England. 2000 w. Engng—Feb. 16, 1906. No. 75287 A.

Valve Motion.

Joy's Valve Motion. Illustrated description of a radial motion that is popular on British railways and in Japan. 1000 w. Ry & Loc Engng. Feb., 1906. No. 74855 C.

Wheels.

Turning Driving Wheels. Gustave Giroux. An illustrated article explaining in detail the steps taken to increase the output at the Angus shops of the Canadian Pacific Ry. 2200 w. Am Engr & R R Jour—Feb., 1906. No. 74852 C.

NEW PROJECTS.

Canada.

Canada's New Railways. A review of recent work accomplished and proposed. Map. 2200 w. Engr., Lond.—Feb. 9, 1906. No. 75068 A.

Philippines.

Horseback Inspection of the Philippine Railroad Projects. L. E. Bennett. An illustrated narration of some of the writer's experiences. 2500 w. R R Gaz—Vol. XL. No. 8. No. 75239.

Switzerland.

New Railway Projects in Switzerland (Neue Schweizerische Eisenbahnprojekte).

We supply copies of these articles. See page 155.

Dr. R. Moser. A discussion of proposed communications over the Eastern Alps, comparing the tunnel routes by way of the Greina Pass and the Splügen Pass. Two articles. 4500 w. Schweiz Bauzeitung—Feb. 3, 10, 1906. No. 75126 each B.

PERMANENT WAY AND BUILDINGS.

Constructor.

Notes on American Permanent Way Construction (Einige Bemerkungen über den Oberbau Amerikanischer Bahnen). E. Giese. A general description of the track construction of American railways, including road bed, rails, sleepers, and joints. 3500 w. Zeitschr d Ver Deutscher Ing—Jan. 20, 1906. No. 75100 D.

Railroad Construction Classification—Construction Expenses and Construction Record. Charles Hansel. Gives a subdivision of the classification of construction expenses as set forth by the Interstate Commerce Commission, providing a close analysis which may be extended. 3500 w. Ry Age—Feb. 23, 1906. No. 75252.

Dust.

The Prevention of Dust on Roads and Railway Tracks by Sprinkling with "Westrumite." Describes this petroleum product, which has been used in Europe and is being introduced in America, giving its advantages, disadvantages and cost. 1600 w. Eng News, Feb. 22, 1906. No. 75246.

Railroad Engineering.

The Division Engineer. Discusses experiences occurring in railroad work, dealing in the present number with maintenance work. 1200 w. R R Gaz. Vol XL. No. 6. Serial. 1st part. No. 74948.

Railroad Offices.

General Features and Foundation Details, New Office Building, New York Central Lines. An illustrated description of an important and interesting building to be built in connection with the improvements at the New York terminal. 2500 w. Eng Rec—Feb. 24, 1906. No. 75262.

Shops.

New Locomotive and Car Shops of the Louisville and Nashville Ry. Illustrated description of the new shops at South Louisville, Ky. 2000 w. Eng. News—Feb. 8, 1906. No. 74914.

Signalling.

Progress in the Use of the Block System. Gives a table of statistics of railroad lines in the United States on which the block system is in use, with explanations. 2200 w. R R Gaz—Vol. XL. No. 5. No. 74820.

Station.

The Pennsylvania Station in New York. Illustration, and plans at different levels, and cross-section profiles, with descriptive notes. 1000 w. R R Gaz—Vol. XL. No. 6. No. 74947.

Surveying.

See Civil Engineering, Measurement.

Terminals.

East Altoona Freight Locomotive Terminal. This large locomotive terminal of the Pennsylvania railrooad is illustrated and described. 1800 w. Am Engr & R R Jour—Feb., 1906. Serial. 1st part. No. 74851 C.

Recommendations of the Government Commission Appointed to Report upon the Improvement of the Railway Connections of Amsterdam (Verslag van de Staatscommissie tot het Instellen van een Onderzoek naar de Wijze van Verbetering der Spoorwegverbindingen om Amsterdam). R. A. van Sandick. An exhaustive review of the report of the Commission, with maps, profiles, and sections. 8000 w. 2 plates. De Ingenieur.—Feb. 3, 1906. No. 75153 D.

Southern Pacific Terminal Depot at Alameda Mole. Illustrated detailed description of the terminal arrangements recently built to replace the terminal destroyed by fire. 1200 w. Ry Age—Feb. 16, 1906. No. 75035.

The Operation of a Busy Terminal District. C. H. Ketcham. Suggestions for organization and management, with a brief description of working at the Hoboken terminal of the D., L. & W. R. R. Also discussion. 10000 w. Pro N Y R R Club—Jan. 19, 1906. No. 75089.

Tunnels.

See Civil Engineering, Construction.

TRAFFIC.

Car Supply.

Ways and Means to Maintain Car Supply. L. C. Bihler. Abstract of an Address before the Traffic Club of Pittsburg. Calls attention to features needing correction, and the need of practical cooperation between shippers, motive power, operating and traffic departments of railroads. 1700 w. Ry Age—Feb. 23, 1906. No. 75251.

Rates.

Argument against Two-cent Passenger Rate in Ohio. James McCrea. Address before House committee on railroads and telegraphs of the Ohio Legislature. 3000 w. Ry Age—Feb. 9, 1906. No. 74958.

Senator Lodge on Rate Regulation. Abstract from speech on rate regulation in the United States Senate, Feb. 12. 4000 w. R R Gaz—Vol. XL. No. 8. No. 75240.

We supply copies of these articles. See page 155.

MISCELLANY.

Easement Damages.

The Park Avenue Cases. Editorial review of a legal suit and a recent decision of the Supreme Court which will cost the New York Central Railroad some millions of dollars in damages. 2000 w. R R Gaz—Vol. XL. No. 6. No. 74945.

Education.

Railway Education. Prof. E. R. Dewsnup. Suggestions for the special training of railroad education of men already in the service. 6000 w. Pro St Louis Ry Club—Jan. 12, 1906. No. 74794.

Railroad History.

Two Object Lessons in Railroad History. A comparison of progress and conditions of the railroads in the Housatonic and the Naugatuck valleys, both roads having become a part of the N. Y., N. H., & H. R. R. system. 1500 w. R R Gaz. Vol. XL. No. 7. No. 75020.

STREET AND ELECTRIC RAILWAYS

Alpine Railway.

A Gravity Cable Railroad in the Swiss Alps. Illustrated description of the remarkable railway in the Swiss Alps, connecting Lauterbrunnen with Mürren. 1000 w. Sci Am—Feb. 24, 1906. No. 75085.

The Sernfthal Railway. Illustrated description of an electric railway through an Alpine valley famous for its beautiful scenery. 1600 w. Engr., Lond—Feb. 23, 1906. No. 75378 A.

Berlin.

New Transportation Projects for Berlin (Die Neuen Berliner Verkehrsprojekte). Adolf Müller. A review of the plans now under consideration for passenger transport in Berlin; including subways, motor omnibus lines, and tramways; with maps and plans of the various projects. Serial. Part I. 3500 w. 1 plate. Glasers Annalen—Feb. 1, 1906. No. 75-121 D.

Electric Railways.

Technical Considerations in Electric Railway Engineering. F. W. Carter. Read before the Inst. of Elec. Engrs. (Abstract.) Also discussion. Discusses the question of the electrification of steam railways, its problems and the systems, their advantages and disadvantages. 10000 w. Elect'n, Lond—Jan. 6, Feb. 2, 1906. Serial. 2 parts. No. 74987 each A.

The Construction of the Rochester, Syracuse and Eastern Railway. Illustrated description of the construction of a road designed for heavy traffic. 3500 w. Eng Rec—March 3, 1906. No. 75407.

Freight.

Freight-Handling by the Des Moines Interurban Railway Co. An illustrated account of an electric railway that has found hauling freight profitable. 3500 w. Ry & Engng Rev—Feb. 10, 1906. No. 74960.

History.

A Quarter Century of Electrical Railway Engineering. Franz Koester. An illustrated review of the development of electric traction since1879, showing the progress from the early experimental lines to the design of the modern heavy alternating-current locomotives. 2500 w. Engineering Magazine—March, 1906. No. 75166 B.

Illinois.

The Illinois Traction System. Illustrated description of recent improvements and extensions in Central Illinois. 5800 w. St Ry Rev—Feb. 15. No. 75229 C.

Interurban.

The Rochester, Syracuse & Eastern Railway. Illustrates and describes the construction of this electric line in New York state. The work is of special interest, as the territory traversed will be served in competition with the New York Central steam road. 3000 w. Ry & Engng Rev.—Feb. 10, 1906. No. 74961.

Lightning.

Lightning Protection. J. V. E. Titus. Read before the Ohio Int. Ry. Assn. Discusses features of lightning arresters and their methods of operation. 3500 w. St Ry Rev—Feb. 15, 1906. No. 75230 C.

Overhead Equipment.

Notes on the Construction and Maintenance of Overhead Equipment. Robert N. Tweedy and H. Dudgeon. Abstract of a paper read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Discusses the variation in cost, the poles, bases, wires, insulators, &c., in the present number. 4500 w. Elect'n, Lond—Feb. 16, 1906. Serial. 1st part. No. 75276 A.

Permanent Way.

The "Romapac" System of Tramway Permanent Way. Illustrates and describes a system in which a detachable head or wearing surface is fitted to the rail, explaining its advantages. 1800 w. Engng—Feb. 9, 1906. No. 75073 A.

We supply copies of these articles. See page 155.

Rapid Transit.

The New Philadelphia Rapid Transit Subway. J. A. Stewart. Describes the completed section recently opened, and features of the construction. Ills. 1200 w. Munic Engng—March, 1906. No. 75338 C.

Rolling Stock.

Experimental Rolling Stock for the Blankenese and Ohlsdorf Suburban Railway. Gustav Dietl. Translated from *Elektrische Bahnen und Betriebe.* Illustrates and describes the cars built for these lines near Hamburg, which are operated by single-phase alternating-current of a frequency of 25 cycles per second and a mean voltage of 6,000. 4500 w. Tram & Ry Wld—Feb. 8, 1906. No. 75294 B.

Signalling.

Automatic Train Stopping. Illustrates and describes devices used on the Boston Elevated, N. Y. Subway, and other lines. 2300 w. Ry & Loc Engng—Feb., 1906. No. 74854 C.

Single Phase.

Comparison Between Single-Phase and Three-Phase Equipment for the Sarnia Tunnel. C. L. de Muralt. Compares the advantages of the two alternating-current systems, especially considering the three-phase system. 5000 w. St Ry Jour—Feb. 17, 1906. No. 75031 C.

Gas Power in the Operation of High Speed Interurban Railways. J. R. Bibbins. Briefly describes this single-phase high-voltage system of the Warren & Jamestown railway, and the exclusive use of gas power. Ills. 5800 w. Eng Rec—Feb. 17, 1906. No. 75052.

Single-Phase Alternating Current Railway Work. Lionel Calisch. Considers the various single-phase motors which can be used for traction purposes and their application to railway work. Ills. 3500 w. Sci Am Sup—Feb. 24, 1906. No. 75087.

Single-Phase Traction on the Borinage Railway. Abstract of a description published by the Allgemeine Elektricitäts-Gesellschaft. The line runs through a coal-mining district in Belgium. Ills. 1700 w. Tram & Ry Wld—Feb. 8, 1906. No. 75295 B.

The Warren and Jamestown Single-Phase Railway. Illustrated description of this electric line and its equipment. Horizontal gas engines are used as prime sources of driving power, and the single-phase alternating current system. 3500 w. R R Gaz—Vol. XL., No. 7. No. 75024.

Traction by Single-Phase Alternating Current at 15,000 Volts (Traction par Courant Alternatif Simple à 15,000 Volts). S. Herzog. Detailed description with illustrations, of single-phase electric locomotive, made by the Oerlikon Works, for the Oerlikon-Wettingen railway, near Zürich. 2500 w. 1 plate. Génie Civil—Feb. 10, 1906. No. 75129 D.

Snow.

The Snow Problem in Marquette. Hamilton Baluss. Illustrates and describes methods of combatting snow when the fall is very heavy. 1200 w. St Ry Jour—Feb. 17, 1906. No. 75032 C.

Station.

The Grand Avenue Station of the Consolidated Railway Company at New Haven, Conn. Illustrated description of a plant which is producing power at such low rates as to make a detailed study of the equipment and operation of interest. 2500 w. St Ry Jour—March 3, 1906. No. 75351 C.

Tube Railways.

The Baker Street and Waterloo Railway. An illustrated description of this first of the new tube railways of London now approaching completion. 3300 w. Elect'n, Lond—Feb. 16, 1906. Serial. 1st part. No. 75274 A.

Tunnel.

The Kingsway Shallow-Tunnel Tramway. Gives an outline of the scheme and a detailed description of the completed portion and its electrical equipment. Ills. 2000 w. Elect'n, Lond—Feb. 2, 1906. Serial. 1st part. No. 74988 A.

Waterproofing.

Waterproofing at the Subway Power House, New York. Illustrates and describes the Winslow method as applied to the basement of the 59th St. power house of the Interborough Rapid Transit Co. 700 w. Eng Rec—Feb. 17, 1906. No. 75053.

Wheels.

Some Causes of Excessive Wheel Wear. Franklin M. Nicholl. Calls attention to some causes of irregular wear. Ills. 1300 w. St Ry Jour—March 3, 1906. No. 75352 C.

We supply copies of these articles. See page 155.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer. *w.* Pittsburg.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.

Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Zeitschrift. *w.* Berlin.,
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe,U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland. Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Nile.

The Nile in 1904. By Sir William Willcocks, K. C. M. G., F. R. G. S. Size, 10 in. by 7 in.; pp. 225. Price, 9 shillings. London: E. & F. N. Spon, Limited. New York: Spon & Chamberlain.

In view of the important engineering works which have already been constructed for the improvement and regulation of Egyptian irrigation on the Nile, and still more because of the works yet to be undertaken, this is a welcome contribution to the literature of hydrology.

Sir William Willcocks takes the occasion of the publication of the Egyptian blue book report on the basin of the upper Nile, by Sir William Garstin, as the basis of his book, and aims to bring Lombardini's "Hydrology of the Nile" down to date, a work for which his own experience in recent engineering works in India renders him eminently fitted. He divides the work into five sections or chapters, these treating successively of the river in general, of its tributaries, the present methods of its utilisation, projects for the extension of its utilisation, and a review of the vases and geology of Egypt, this last chapter being the work of Mr. H. J. L. Beadnell, F. G. S., F. R. G. S.

The first two chapters include some valuable profiles and sections of the stream and its most important tributaries, while the section on the utilisation of the river gives some important data concerning the volumes of discharge, the nature of the muddy deposit and the existing cultivation, and methods of irrigation.

So far as new projects are concerned, these form the most interesting portion of the book. Of the total irrigable area of Egypt estimated at 6¼ million acres there are two million which need artificial works for their perennial irrigation, and such works would increase their value by £30 per acre, or a total gain of £60,000,000.

To effect this irrigation will require the storage of four milliards of cubic metres of water, on the basis of one milliard to half a million acres. The Assuan dam provides for but one milliard of cubic metres, and its supply is already all devoted to special tracts, so that something more must be done.

Briefly, the recommendations of Sir William Willcocks are: to raise the height of the Assouan dam by six metres, adding another milliard of cubic metres to the capacity of the reservoir behind it. This being done, the Wady Rayan depression should be utilised as a reservoir, as was clearly pointed out by Mr. Cope Whitehouse, twenty years ago, this supplying the other two milliards of cubic metres, and forming a modern counterpart to the lake Moeris of ancient Egypt.

This recommendation has added interest at the present time because of the success which has attended the efforts of Mr. Whitehouse to prove his claims to the origination of this idea, and to sustain the correctness of the project against the opposition of its detractors.

In view of the interest which the development of these important works is likely to attract, the book of Sir William Willcocks will prove a valuable store of facts and information about the Nile not only for the engineer but also for the general reader.

Physics.

Physics. By Charles Riborg Mann and George Ransom Twiss. Size, 8 in. by 6 in.; pp. x, 453. Price, $1.25. Chicago: Scott, Foresman & Co.

The older text books on physics were modelled somewhat after the scholastic treatises on mathematics, the illustrations and examples being selected from laboratory and lecture room apparatus and methods, apparently without any intention of indicating to the students that the phenomena under consideration were occurring all about him in the course of daily life. Now comes along a pair of heretical teachers, who actually have the temerity to preface their book with a picture of the 20th Century Limited, and introduce

the subject with references to the savage making his first fire, and talk about telephones, trolley cars, and other such vulgar things.

We are heartily glad that Messrs. Mann and Twiss have thus begun the good work, and still better pleased that they have conducted it without striving after a so-called popularity which is supposed to condone flippancy and inaccuracy. The book is a good one, well up to date, and filled with intelligent and interesting examples and illustrations. The phenomena of circular motion are illustrated by the action of railway trains on curves, and by the spectacle of the "loop-the-loop"; pneumatic and hydraulic laws are demontrated in connection with modern waterworks engines, air compressors, and rock drills. Santos-Dumont replaces Montgolfier; the equipment of the modern electric power station appears to crowd out the crude dynamos of the lecture-room table. At the same time theory is not neglected, but the student is led to perceive the applications of the laws and theories of physics to his daily surroundings, and things so learned are not forgotten, and what is still better they are so intimately connected with habits of thought that loose thinking in other lines is minimized, and one of the fundamental ideas of education furthered. It is to be hoped that some of the other departments of elementary education will be supplied with similar modern text books; there is certainly room for them.

Concrete.

Concrete Construction About the Home and on the Farm. Size, 8½ in. by 5½ in.; pp. 127. New York: The Atlas Portland Cement Co.

The use of domestic Portland cement has grown in the United States from 150,000 barrels in 1885, to more than 25,000,000 barrels in 1904. Much of this is due to the employment of concrete in foundation and general construction, but a large quantity of cement is used in general building work. This little book is intended to encourage the employment of cement and concrete construction in household and farm building work, and it shows very clearly how much structural work formerly made of timber, and carpentry work may be replaced by neat and even ornamental buildings, wholly fireproof, and very durable, and built largely with the use of such labor as is available about the farm and in the country. Details of simple elements in reinforced concrete are given, with numerous illustrations of cellar, floor, barn, and outbuilding construction, enabling the ordinary builder to accomplish very satisfactory results with comparatively unskilled labor.

Valve Gears.

Link Motions, Valves, and Valve Setting. By F. H. Colvin. Size, 6 in. by 4 in.; pp. 82. Price, 50 cents. New York: The Derry-Collard Co.

This little book is intended to give a clear idea of the manner in which locomotive reversing valve gears of the type commonly known as the Stephenson link motion should be designed and adjusted.

The recently discovered evidence that this motion was invented by Williams, and not by Howe, is noted, and the writer then proceeds to explain, by the aid of simple diagrams, and in very clear language the manner in which the link motion operates. The book is undoubtedly a useful one for men to whom the more elaborate treatises of Auchincloss or Zeuner are not easy reading, and it will doubtless fill a place among books for the traveling locomotive engineer very acceptably. A brief mention is made of other gears than the ordinary link motion, and there might have been more space given to the Walschaert gear, which is undoubtedly coming into extensive use in the United States in connection with the development of the four-cylinder compound locomotive.

Bridges.

The Design and Construction of Metallic Bridges. By William H. Burr and Myron S. Falk. Size, 9 in. by 6 in.; pp. xiii, 532. Price, $5.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Although this book is based upon the ninth edition of Professor Burr's treatise on bridge and roof trusses, it has been so thoroughly rewritten and had so much new matter added that it is practically a new work, and as such has been given a new title.

The present volume is intended to form a comprehensive treatise covering all types of trusses used to a material extent in American practice, with the exception of suspension bridges and bridges having arched ribs, these being intended to form the subject of a later work. Analytical methods are generally employed, and in the treatment of swing bridges these are supplemented by the use of the methods of influence lines and deflections.

After a brief historical introduction, the work discusses the general types of trusses, with the nature and magnitude of loads to be carried, together with the specifications of leading railroads and bridge builders in the United States. The succeeding chapters treat of moments and shears, for plate girders; of trusses with parallel and horizontal chords, and of non-continuous trusses with chords not parallel, this chapter also including roof truss-

es. Swing bridges are very fully treated, and the book concludes with an analysis of wind stresses, and a study of details of construction.

Measurements.

Elektrotechnische Messkunde. Von Arthur Linker. Size, 210 mm. by 140 mm.; pp. viii, 442. Price, 10 marks. Berlin: Julius Springer.

A useful handbook both for the technical laboratory and for the practising electrical engineer in the office or in the field.

After an extended chapter on the general methods of electrical measurement, there follow detailed sections on magnetic measurements, measurements with direct and with alternating current machines, and a chapter on the practical methods of photometry. The book contains some portions involving a familiarity with the principles of higher mathematics, but these are so arranged as to cause no interference with the more practical parts, while giving demonstrations of methods for those who desire to follow out such investigations.

There are many diagrams, and graphical methods are freely employed throughout, the book being an excellent example of German thoroughness and care, while the appearance of the volume is fully in keeping with the high reputation of the publisher.

Dynamos.

Dynamo-Electric Machinery. By Silvanus P. Thompson. Seventh Edition. Volume II. Alternating-Current Machinery. Size, 9 in. by 6 in.; pp. xx, 848. Price, 30 shillings. London: E. & F. N. Spon. New York: Spon & Chamberlain.

During the nine years which have elapsed since the sixth edition of Dr. Silvanus Thompson's book of alternating-current machinery appeared there has been a remarkable extension in the use of alternating currents, and many developments in the machinery itself, so that it has been found necessary to prepare what is practically an entirely new work. A new chapter on periodic functions has been written, and the method of harmonic analysis, in a novel and simplified form, applied to the discussion of the wave-form of alternating electromotive forces and currents.

In the chapter devoted to magnetic leakage and armature reactions the principle of superposition of magnetic fields is extensively employed, and a distinction is made between the permanent and the periodic portions of armature interference, this rendering it possible to simplify the method of predetermining the curve of performance of an alternator on an inductive load.

The question of windings of alternators for single-phase, two-phase, and three-phase machines is considered both for generators and for motors, with photographs showing the practical methods employed in the works of prominent manufacturers. The practical nature of the book also appears in the extent to which methods of design are considered, the formulas given being those actually employed in the shop, including constants derived from the experience of the best makers. In this portion of the book methods of design are considered for machines of various speeds, including those driven by high-speed steam turbines, as well as those connected to large reciprocating engines.

Alternating-current motors are fully discussed, a chapter being given to the single-phase induction motor, and one to the alternating-current commutator motor.

The book concludes with an appendix upon the standardisation of voltages, frequencies, and ratings, comparing the recommendations of the British Engineering Standards Committee with the American and German rules.

Electrical Power.

Principles of Electrical Power for Mechanical Engineers. By A. H. Bate. Size, 7 in. by 5 in.; pp. xii, 204. Price, 4 shillings 6 d. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain.

This convenient little work is one of the Finsbury Technical Manuals, prepared both for the use of students, and for reference by practising mechanical engineers. It deals with continuous-current work only, and that from the end of the motor alone, the current being assumed to be furnished to the establishment, so that problems of distribution and control are included, as well as the design and rating of motors, and their applications to machine driving. Such a work will doubtless find many readers to whom it will be welcome, and it may lead them to larger and broader works in the field of applied electricity.

Shop Methods.

Machine-Shop Tools and Methods. By W. S. Leonard. Size, 9 in. by 6 in.; pp. vii, 554. Price, $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

This book was originally prepared for use in the course of instruction given in the shops of the Michigan Agricultural College, and it has now been extended and issued in a new edition for more general circulation and use. In this form it constitutes an excellent instruction for

students, and should also be very useful for the apprentice and for the ambitious mechanic who is anxious to make more rapid progress in his knowledge of shop methods than he can obtain in the course of his daily work. There are many workmen, both student-apprentices and helpers who, by the use of such a book could obtain a familiarity with ordinary workshop processes in a far shorter time than is possible by simply following the shop routine in the position which he may hold, and it is in such a way that much trouble in connection with the apprenticeship question may be obviated. Shop methods cannot be learned from books alone, but such aids to an acquisition of modern tools and their operations may be greatly facilitated by such means.

The work is copiously illustrated, and the fact that many of the illustrations are from the trade catalogues of eminent tool builders does not detract from their value.

Space Telegraphy.

Wireless Telegraphy; Its History, Theory, and Practice. By A. Frederick Collins. Size, 9 in. by 6 in.; pp. xii, 300. Price, $3.00. New York: McGraw Publishing Company.

In the course of the decade which has passed since the appearance of telegraphy through space by means of magnetic waves it has taken its place as an important element in social and commercial economics. Many changes have been made in apparatus and methods, and hence a review of the development of the art and some indication of the lines along which progress may be expected will be acceptable. Mr. Collins, whose name is not unknown in connection with this subject, reviews the subject as a whole, discussing first the physical phenomena upon which the operation of space telegraphy depends; giving chapters upon the ether, upon wave motion, electric waves, the disruptive discharge, and electrical oscillations. From these theoretical elements he passes to the consideration of oscillators, interruptors, transmitters, detectors, and all the detailed apparatus by means of which the waves sent out by the transmitting station are received and interpreted at a distance.

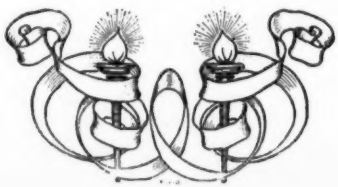
A special chapter is given to the subject of syntonization, including the methods of tuning by means of which a message may be received only by the station for which it is intended; the book concluding with a chapter on wireless telephony.

Fire Protection.

L'Incendie: Ses Causes, sa Prevention, son Extinction. Par Félicien Michotte. Size, 250 mm. by 160 mm.; pp. vi, 564. Price, 16 fr. 50. Paris: Vve. Ch. Dunod.

This work, issued under the patronage of the Technical Fire Prevention Committee of France, may be considered as a semi-official publication, exhibting the latest French practice, both as regards fire prevention and fire extinction.

Treating first of the causes of fires and the effects which may be produced under various conditions, M. Michotte passes to the more technical portion of his work in discussing fire-proof construction, and the methods which may properly come under the heading of preventive methods, such as automatic fire-alarms, automatic sprinkler systems, and the like. In these, as in the other portions of the work, the author shows himself thoroughly familiar with the practice of other countries, citing the methods employed in Germany, England, and the United States with fulness and effect.

Passing to methods of fire extinction, the book discusses local appliances, such as chemical fire-extinguishers, permanent hose connections, force pumps, etc., followed by a review of the apparatus and methods of the regularly organized fire departments.

A chapter is devoted to methods of fire prevention and extinction in the country, where fully equipped departments are not available, and the work closes with a discussion of the protection of theatres, factories, and other buildings occupied by many people, against the dangers of fire alarms. The book is an excellent example of the specialized type publications more common with the Continental press than in Great Britain or the United States, and it might well serve as a model for similar works devoted more particularly to local methods.